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REVISION OF AUSTRALIAN Berosus LEACH (COLEOPTERA : HYDROPHILIDAE)

BY H. S. WATTS

Summary

The Australian members of the hydrophilid genus *Berosus* are revised and redescribed. A key to species is give. Thirty-two species are recognised of which 18 are described as new: *B. amoenus*, *B. arcus*, *B. aquilo*, *B. dallasae*, *B. gibbae*, *B. josephenae*, *B. juxta discolor*, *B. reardoni*, *B. macropunctatus*, *B. sadieae*, *B. nicholasi*, *B. niger*, *B. quadrapunctatus*, *B. trishae*, *B. timmsi*, *B. veronicae*, *B. ralphi* and *B. vijae*.

REVISION OF AUSTRALIAN *BEROSUS* LEACH (COLEOPTERA: HYDROPHILIDAE)

C. H. S. WATTS

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The Australian members of the hydrophilid genus *Berosus* are revised and redescribed. A key to species is given. Thirty-two species are recognised of which 18 are described as new: *B. amoenus*, *B. arcus*, *B. aquilo*, *B. dallasae*, *B. gibbae*, *B. josephenae*, *B. juxtadiscolor*, *B. reardonii*, *B. macropunctatus*, *B. sadieae*, *B. nicholasi*, *B. niger*, *B. quadrapunctatus*, *B. trishae*, *B. timmsi*, *B. veronicae*, *B. ralphi* and *B. vijae*.

The following synonymies are proposed: *B. flindersi* Blackburn = *B. discolor* Blackburn; *B. ovipennis* Fairmaire = *B. similans* Blackburn = *B. stigmaticollis* Fairmaire = *B. auriceps* Blackburn; *B. blackburni* Zaitz = *B. approximans* Fairmaire; *B. quarinius* d'Orchmont = *B. queenslandicus* Blackburn; *B. gravis* Blackburn = *B. australiae* Mulsant.

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The hydrophilid fauna of Australia is relatively rich in species and numbers of individuals. They form a conspicuous part of the aquatic fauna. In general they are well-collected and well-represented in collections. Despite this they have received little recent taxonomic attention.

A major difficulty in dealing with *Berosus* Leach, 1817 in Australia was the inadequacies of existing keys which reflected a weak taxonomic base exemplified by the fact that some 18 of the 32 known species were undescribed, including the commonest southern species. At the same time some widespread species were described under as many as five different names.

The last major attempt to revise Australian *Berosus* was by Blackburn in 1898.

Some characters used in the key, such as leg colour and details of the punctuation, are not totally reliable, but the male genitalia have provided good characters in all cases.

The genus *Berosus* is a member of the subfamily Berosinae which is characterized by a markedly deflexed head, seven- or eight-segmented antennae and meso- and metasternae without a continuous common keel.

Berosus can be separated from the other Australian genera in the subfamily (*Regimbartia*, *Globaria* and *Amphiops*) by possession of protruding eyes, seven-segmented antennae, and striae on elytra, although in some species these are partially masked by strong elytral punctations. Adults of all but a few of the smaller species are yellow-brown in colour. They are found mainly among vegetation at the bottom and sides of ponds and pools. Adults are often taken at light sometimes some distance from water. The larvae are distinctive

with a series of lateral filamentous appendages and live in pools in similar situations to the adults. I know of no detailed description of the larvae of any Australian species.

Berosus is a large cosmopolitan genus and many attempts have been made to subdivide it, none of which appear particularly satisfactory to me. In particular, the subgenus *Hygrotrophus* W. Macleay which includes only the species *B. (H.) nutans* and *B. (H.) devisi*, both Australian species, seems unwarranted and to be based on an undue emphasis on the punctuation of the upper surface.

Within Australian species there are five more or less distinctive groupings.

Group 1 species are small, have the midline of the mesosternum produced downwards in a distinct ridge, head black, metacoxal process weakly to moderately lobed laterally, last abdominal segment notched and the second elytral stria 1/4 the length of the elytron (*B. discolor*, *B. approximans*, *B. reardonii*, *B. juxtadiscolor*, *B. timmsi*).

Group 2 species are small, with the midline of the mesosternum produced downwards in a distinct pillar, head black, metacoxal process strongly lobed laterally, the last abdominal segment notched, the second elytral stria about 1/2 the length of elytron, and with strongly developed medial ridge on first abdominal segment (*B. macropunctatus*, *B. quadrapunctatus*, *B. trishae*).

Group 3 species are similar to Group 2 species except for a less developed medial ridge on first abdominal segment, strongly humpbacked which is associated with the presence of a space between elytral striae 7 and 8 and/or 8 and 9 in the middle of the elytron (*B. involutus*, *B. niger*, *B. arcus*).

Group 4 species are similar to Group 2 but are

larger and have the second elytral stria reaching about two-thirds the length of the elytron (*B. duplopunctatus* and *B. queenslandicus*).

Group 5 species are generally larger with brown heads, midline of mesosternum with a weak central keel, and metacoxal process without lateral lobes (*B. nutans*, *B. pulchellus*, *B. dallasi*, *B. macumbensis*, *B. minutipennis*, *B. amoenus*, *B. josephinae*, *B. gibbae*, *B. majusculus*, *B. veronicae*, *B. aquila*, *B. australiae*, *B. decipiens*, *B. sadieae*, *B. nicholasi*, *B. vlfiae*, *B. subovatus*, *B. ralphi* and *B. debilipennis*).

Groups 1-4 have similarities with each other and roughly correspond to the subgenus *Berosus* Hope. Group 5 species correspond to the subgenera *Enoplurus* Hope and *Hygrotrichus* W. MacLeay. Since *Berosus* is a world-wide genus, further consideration of subgeneric groupings should include extra-Australian species and is beyond the scope of this revision.

The collections from which specimens were examined are listed under the following abbreviations:

AM	Australian Museum, Sydney.
ANIC	Australian National Insect Collection, Canberra.
BM(NH)	British Museum (Natural History), London.
CW	Private collection of author.
NMV	National Museum of Victoria, Melbourne.
NSW DA	New South Wales Department of Agriculture, Sydney.
NTM	Northern Territory Museum, Darwin.
MNHN	Museum National d'Histoire Naturelle, Paris.
SAM	South Australian Museum, Adelaide.
WAM	Western Australian Museum, Perth.
QPI	Queensland Department of Primary Industry, Mareeba.

KEY TO AUSTRALIAN SPECIES OF *BEROSUS*

1. Midline of mesosternum produced downwards in a distinct pillar (Fig. 10), not projecting backwards between metacoxae. Head black (metallic). Metacoxal process lobed laterally (rudimentary in *B. discolor*). Last abdominal segment notched. Small (< 7 mm). 2
1. Midline of mesosternum with weak central keel, projecting weakly forward between mesocoxae. Head completely or partially brown except *B. pulchellus* which lacks elytral striae and *B. amoenus* which has a predominantly black pronotum and elytra also. Metacoxal process triangular (Fig. 1) 14
- 2, (1) Second elytral stria about 1/4 length of elytron 3
2. Second elytral stria $\geq 1/2$ length of elytron 6

- 3, (2) Rugose portion of metafemur $< 1/2$ length of femur (Fig. 2). Mesosternal pillar flat on ventral edge. *B. discolor* Blackburn
3. Rugose portion of metafemur $\geq 1/2$ length of femur. Mesosternal pillar weakly concave on ventral edge 4
- 4, (3) Rugose portion of mesofemur 1/2-2/3 length of femur. 5
4. Rugose portion of mesofemur $< 1/2$ length of femur *B. approximans* Fairmaire
- 5, (4) Rugose portion of meta- and meso-femora pale, same colour as rest of leg. *B. reardoni* sp.nov.
5. Rugose portions of meta- and meso-femora much darker than rest of leg 7
- 6, (2) Second elytral stria about 1/2 length of elytron, rugose portion of metafemur $\geq 1/2$ length of femur. 8
6. Second elytral stria at least 2/3 length of elytron, rugose portion of metafemur $< 1/2$ length of femur. 13
- 7, (5) Punctures on sides of pronotum uneven in size, interstitial punctures small, subobsolete, hind femur of male with triangular bulge on hind edge *B. timmsi* sp.nov.
7. Punctures on sides of pronotum evenly sized with only a few smaller ones, interstitial punctures moderately marked, hind femur of male normal *B. justadiscolor* sp.nov.
- 8, (6) Space between elytral striae 7 and 8 and/or 8 and 9 greater in middle than at ends of elytron (Fig. 8). Medial ridge on first abdominal segment 1/4 as deep as long, without backward projection on ventral edge 9
8. Elytral striae 7, 8 and 9 subparallel with each other. Medial ridge on first abdominal segment deep 1/3-1/2 as deep as long, with a backward projection on ventral edge 11
- 9, (8) Elytral stria 8 raised and carinate in middle and towards apex. Distance between elytral striae 8 and 9 greatly enlarged in middle (Fig. 8). Interstitial punctures weak, subobsolete. Northern species 10
9. Elytral stria 8 not raised. Interstriae 7-8 as wide or wider than 8-9 (Fig. 9). Interstitial punctures moderately strong. Southern species *B. invalutus* MacLeay
- 10, (9) Rugose portion of metafemur approximately 1/2 length of femur. Punctures on disc of pronotum of two sizes, larger predominating. Posterior portion of carinate eighth interstria at right angles to edge of elytron. Black, except for interstria in apical 1/4 of elytron *B. niger* sp.nov.
10. Rugose portion of metafemur reaches 2/3 length of femur on rear edge. Punctures on disc of pronotum of one size, posterior portion of carinate eighth interstria of approximately 45° to edge of elytron (Fig. 8) *B. arcus* sp.nov.
- 11, (8) Pronotum smooth, shiny, moderately covered with large punctures often with spaces greater than 1/2 diameter of puncture or greater between punctures. Pronotum yellow with three longitudinal black stripes. 12
11. Head and pronotum rugose, densely covered with large punctures, those on pronotum separated

- by narrow ridges. Pronotum black except for extreme lateral margins
B. macropunctatus sp. nov.
12. (11) Rugose portions of mesofemur a little under 1/2 length of femur *B. quadropunctatus* sp. nov.
12. Rugose portions of mesofemur 1/2-2/3 length of femur *B. trishae* sp. nov.
13. (6) Punctures on pronotum of two distinct sizes. Areas between elytral striae with shallow punctures *B. duplopunctatus* Blackburn
13. Punctures on pronotum vary little in size. Areas between elytral striae virtually impunctate
B. queenslandicus Blackburn
14. (1) Punctures on elytron densely and evenly distributed, each with a short seta. Punctures in elytral striae difficult to distinguish from those in interstriae 15
14. Punctures on elytra mostly without setae. Punctures in elytral interstriae scattered, distinct from those in striae 17
15. (14) Punctures on pronotum expanded laterally forming a dense network of closely spaced short striae orientated across the pronotum (Fig. 5)
B. nutans W. MacLeay
15. Punctures on pronotum normal 16
16. (15) Small (<5.0 mm), elytron without striae. Head metallic black *B. pulchellus* W. MacLeay
16. Larger (>3.6 mm), elytra with deeply impressed striae. Rear of head with dark markings
B. dallasi sp. nov.
17. (14) Interstitial punctures towards sides of elytra not as numerous as those on disc, often arranged in a single row 18
17. Interstitial punctures towards sides of elytra more numerous and larger than those on disc, never arranged in single lines
B. macumbensis Blackburn
18. (17) Outer apical spine on elytron long and thin (Fig. 3). Interstitial punctures laterally subobsolete, arranged in one row over most of elytron. Rugose portion of metafemur approximately 1/3-2/3 length of femur. Pale
B. munitipennis Blackburn
18. Not with above combination of characters (Fig. 3) 19
19. (18) Punctures in interstria 3 of two sizes, with small size predominating (Fig. 11). Punctures on disc of pronotum of two sizes mostly large with some smaller ones (e.g. Fig. 7) 22
19. Punctures in interstria 3 of one size, or with only an occasionally smaller one. Punctures on disc of pronotum of one size (e.g. Fig. 6) 20
20. (19) Head black. Interstitial punctures on elytron approximately the same size as those in striae
B. amoenus sp. nov.
20. Head pale brown. Interstitial punctures on elytron smaller than those in striae 21
21. (20) Rugose portions of femore dark-brown
B. josephenae sp. nov.
21. Rugose portion of femore pale-brown
B. gibbae sp. nov.
22. (19) Rugose portions of meso- and meta-femore noticeably darker than rest of femur (see Table 1).
22. Rugose portions of meso- and metafemore of same colour as rest of femur 23
23. (22) Larger (>5.9 mm). Number of punctures in second elytral interstria to level of end of second stria >22. Rugose portion of mesofemur approx. 1/3 length of femur. Male with apical abdominal segment notched
B. majusculus Blackburn
23. Smaller (<6.5 mm). Number of punctures in second elytral interstria back to level of end of second stria usually <26. Rugose portion of mesofemur >1/2 length of femur except in *B. veronicae* 24
24. Rugose portion of mesofemur \leq 1/2. Apical spines on elytron moderately developed (Fig. 4)
B. veronicae sp. nov.
24. Rugose portion of mesofemur >1/2 length of femur see Table 2

SYSTEMATICS

Berosus discolor Blackburn
(Figs 2, 13, 18)

Berosus discolor Blackburn, 1888(1889), p. 829
Berosus flindersi Blackburn, 1888(1889), p. 831, syn. nov.

TABLE 1. Distinguishing characters for four species of *Berosus*.

<i>B. aquilo</i> sp. nov.	<i>B. australiae</i> Mulsant	<i>B. decipiens</i> Blackburn	<i>B. sadiiae</i> sp. nov.
3.3-5.0 mm long	6.5-9.0 mm long	6.1-8.0 mm long	4.5-5.0 mm long
Tips of elytron usually without spines.	Tips of elytron with well-developed spines.	Tips of elytron with well-developed spines.	Tips of elytron usually with well-developed spines.
Third segment of male protarsi approximately same length as segment.	Third segment of male protarsi shorter than second segment.	Third segment of male length of second segment.	Third segment of male length of second segment.
Elytral punctures weak. Strial punctures arranged in one line, over most of elytron.	Elytral punctures usually strong, strial punctures not arranged in one line inwards from stria 7.	Elytral punctures usually weak, strial punctures usually arranged in one line over most of elytron.	Elytral punctures usually weak, strial punctures usually arranged in one line over most of elytron.
Coastal Northern Territory.	Australia-wide.	Wyndham to Cairns.	Coastal Northern Territory.

TABLE 2. Distinguishing characters for five species of *Berosus*.

<i>B. debilipennis</i> Blackburn	<i>B. subovatus</i> Knisch	<i>B. vijae</i> sp. nov.	<i>B. nicholasi</i> sp. nov.	<i>B. ralphi</i> sp. nov.
4.0-6.0 mm long	3.0-5.0 mm long	3.0-4.5 mm long	5.0-6.5 mm long	3.5-4.5 mm long
Apex of elytron rounded or with weak spines.	Apex of elytron rounded or weakly truncated.	Apex of elytron with weak spines.	Apex of elytron with weak to moderate spines.	Apex of elytron truncated or with weak spines.
Punctures in 1st elytral interstria, scattered, not arranged in a row.	Punctures in 1st elytral interstria, arranged in a single row.	Punctures in 1st elytral interstria, arranged in a single row.	Punctures in 1st elytral interstria, scattered, not arranged in a row.	Punctures in 1st elytral interstria, scattered, not arranged in a single row.
Lateral punctation on elytron moderate to strong.	Lateral punctation on elytron weak.	Lateral punctation on elytron moderate to strong.	Lateral punctation on elytron small and weak.	Lateral punctation on elytron small and weak.
Tip of postcoxal process in same plane as rest of underside.	Tip of postcoxal process in same plane as rest of underside.	Tip of postcoxal process in same plane as rest of underside.	Tip of postcoxal process in same plane as rest of underside.	Tip of postcoxal process bent downwards at 45° to rest of underside.
10-18 punctures in second elytral stria.	6-7 punctures in second elytral stria.	8-13 punctures in second elytral stria.	10-16 punctures in second elytral stria.	7-13 punctures in second elytral stria.
First segment of male protarsi much longer than second.	First segment of male protarsi longer than second.	First segment of male protarsi equal in length to second.	First segment of male protarsi equal in length to second.	First segment of male protarsi longer than second.

Types

Berosus discolor: Holotype, male, Pt Lincoln, S.A., in BM(NH), seen.

Berosus flindersi: Holotype, male, Pt Lincoln, S.A., in BM(NH), seen. Paratype, female, in SAM, seen.

Description (number examined 131)

Length 2.8-4.8 mm. Oval, elytra moderately humped, highest behind middle where it is approximately $1/3 \times$ height at shoulder. Apex of elytron rounded, in some subacute and suggestive of a thick broad spine. Head relatively narrow, black, shiny, metallic. Pronotum black with sides broadly brown, often with small central brown spot or band behind front edge, shiny, metallic. Elytron shiny brown, with striae, punctures and a few spots black. Ventral surface black, appendages brown, except for extreme tips of labial palps and rugose portion of meso- and metafemur which can range from light-brown to black. Punctures small, dense. Punctures on head strong, regular, well-impressed, most less than $1/2$ puncture width apart. Punctures on pronotum similar but slightly less dense. Elytral striae well-impressed. Second stria on elytron $1/4$ length of elytron. Punctures in and between striae similar, about same size as on pronotum, strongest laterally, those on extreme humeral angles and between first stria and suture smaller. Mesosternal keel weakly to moderately well-developed, pro-

jecting backwards. Metacoxal process sharply produced backwards in midline, lateral lobes raised, sides diverging towards front, small narrowly oval shiny depression in midline. Keel in midline of first abdominal segment weak, reaching only $1/4$ to $1/3$ of width. Rugose portion of metafemur approximately $1/3$ length of femur. Meso- and meta-tibia strongly spined. Apical abdominal segment with small weak notch.

Male: Protarsi four-segmented, first segment moderately expanded.

Remarks

Less common in collections than *B. approximans*. Readily separated from those other *Berosus* with a well-developed mesosternal keel and short second elytral stria by the small area of rugosity on the femora.

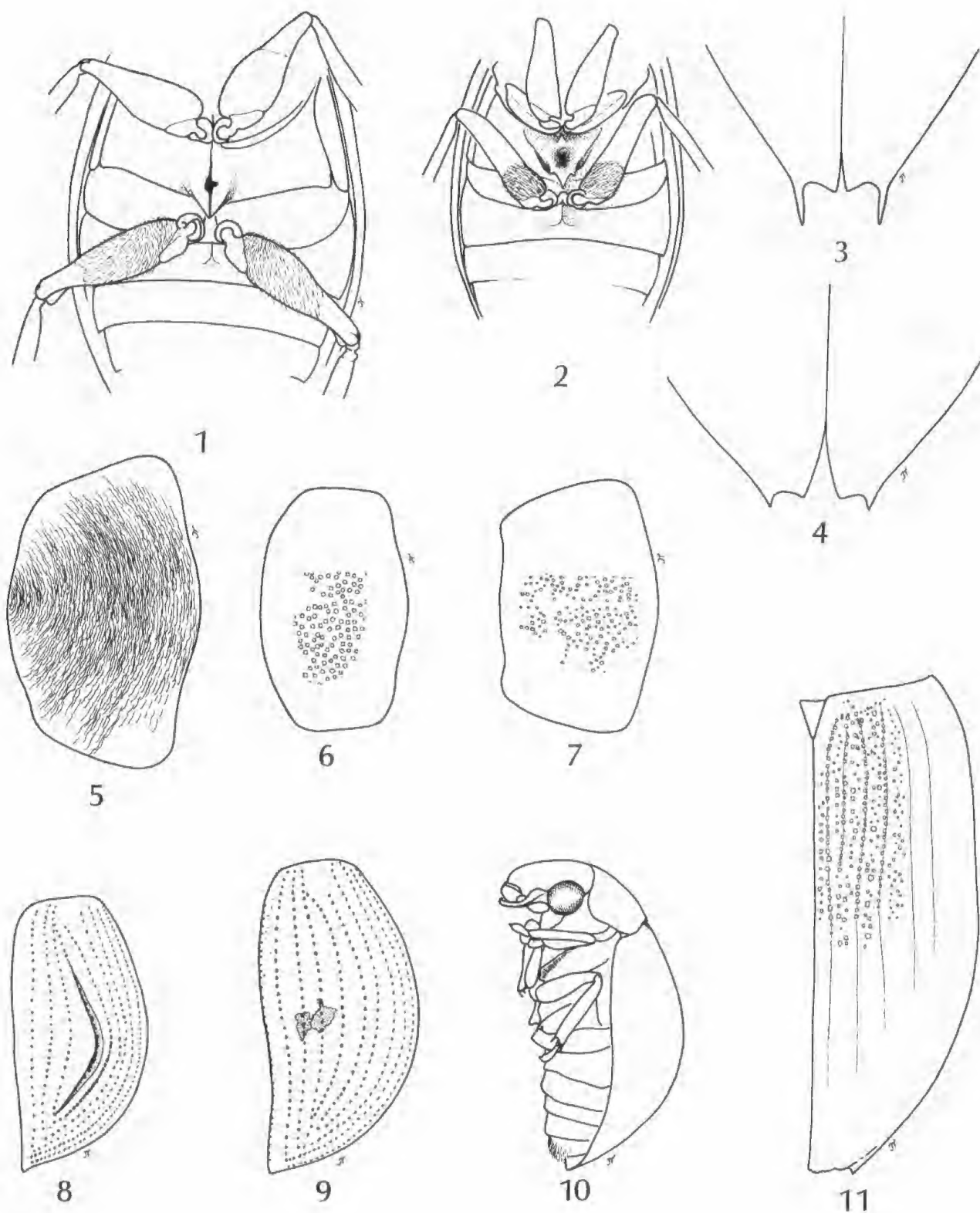
Distribution (Fig. 79)

Coastal southern Australia from Perth, W.A. to Sydney, N.S.W., and Tas.

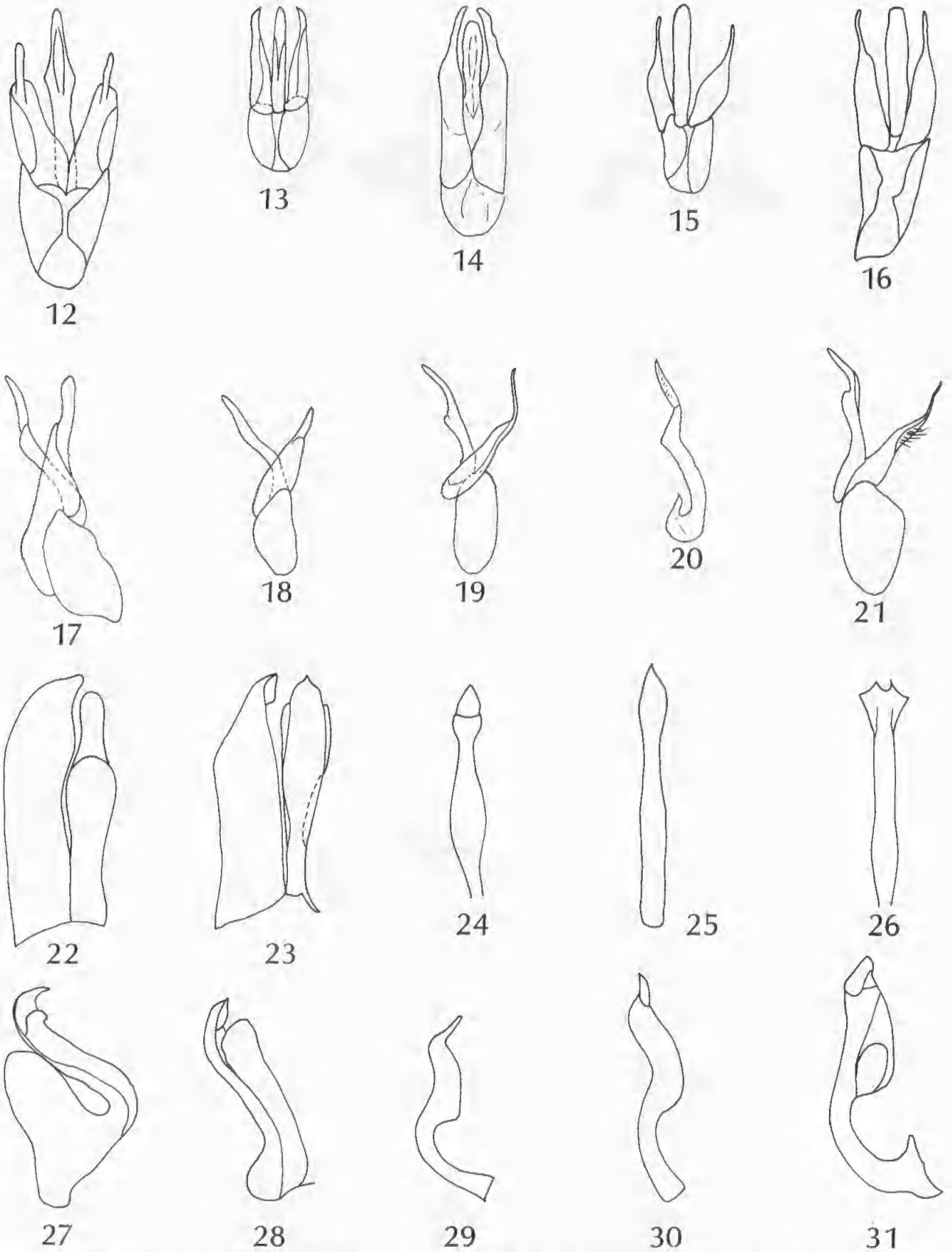
***Berosus approximans* Fairmaire**
(Figs 10, 12, 17)

Berosus approximans Fairmaire, 1879, p. 82.

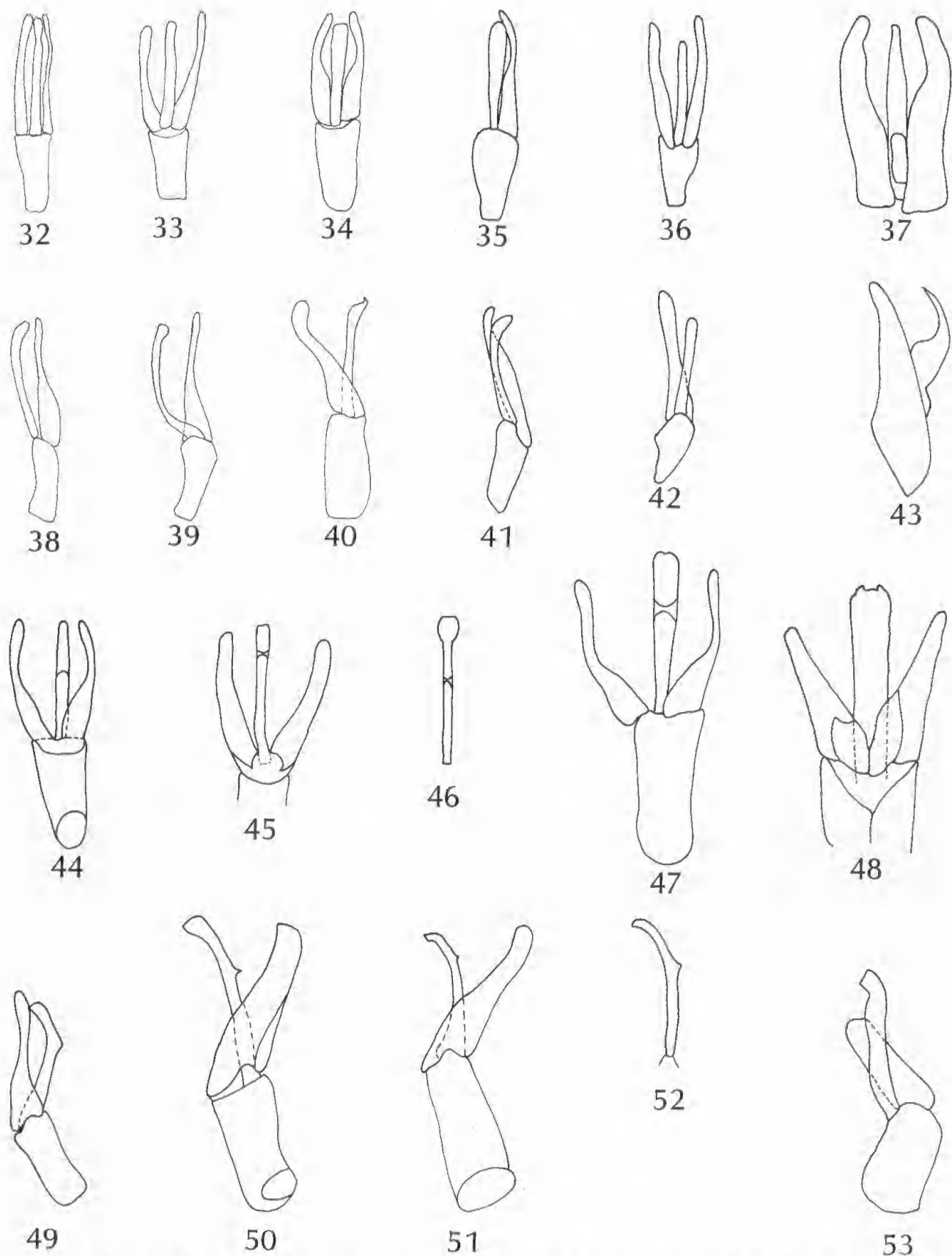
Berosus ovipennis Fairmaire, 1879, p. 82, syn. nov.



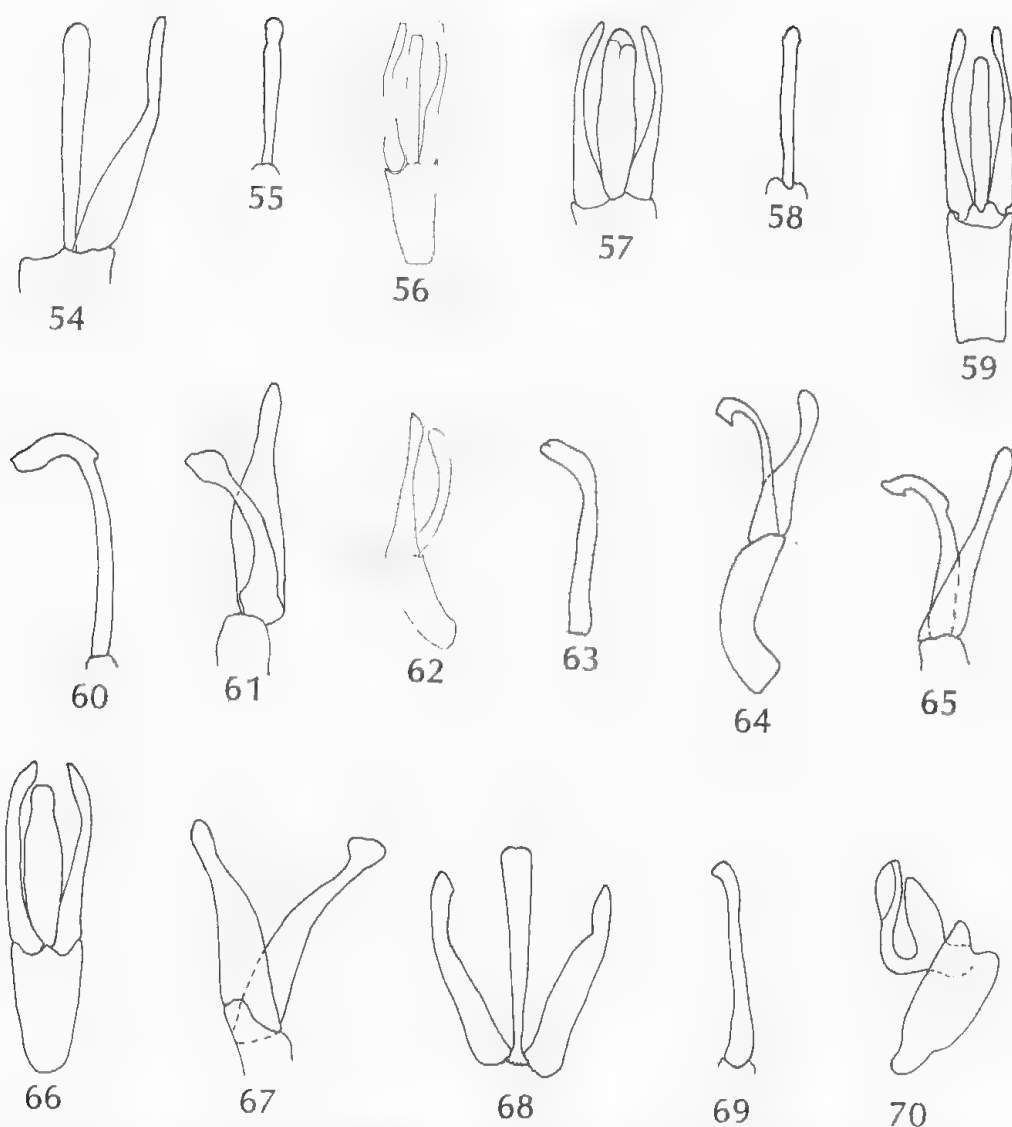
FIGURES 1-11. 1, Midventral region of *B. nicholasi*; 2, midventral region of *B. discolor*; 3, apex of elytra of *B. munitipennis*; 4, ditto, *B. munitipennis*; 5, pronotum of *B. nutans*; 6, pronotum of *B. gibbae* showing punctation on disc; 7, pronotum of *B. arcus* showing punctation on disc; 8, lateral view of elytron of *B. arcus*; 9, lateral view of elytron of *B. involutus*; 10, lateral view of *B. approximans* showing pronotal pillar (shaded); 11, elytron of *B. majusculus* showing punctation of disc.



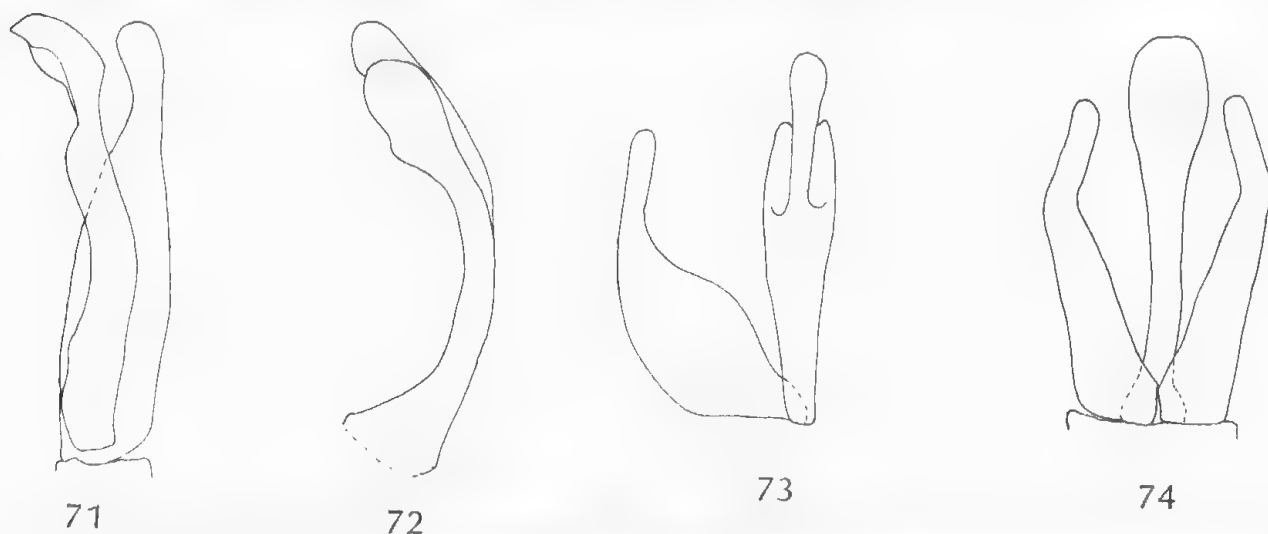
FIGURES 12-31. 12, dorsal view of male genitalia of *B. approximans*; 13, ditto, *B. discolor*; 14, ditto, *B. juxtadiscolor*; 15, ditto, *B. reardoni*; 16, ditto, *B. timmsi*; 17, lateral view of male genitalia of *B. approximans*; 18, ditto, *B. discolor*; 19, ditto, *B. juxtadiscolor*; 20, ditto, *B. reardoni*; 21, ditto, *B. timmsi*; 22, dorsal view of aedeagus and right paramere of *B. duplopunctatus*; 23, ditto, *B. queenslandicus*; 24, dorsal view of aedeagus of *B. arcus*; 25, ditto, *B. niger*; 26, ditto, *B. involutans*; 27, lateral view of aedeagus of *B. duplopunctatus*; 28, ditto, *B. queenslandicus*; 29, ditto *B. arcus*; 30, ditto, *B. niger*; 31, ditto, *B. involutans*.



FIGURES 32-53. 32, dorsal view of male genitalia of *B. dallasi*; 33, ditto, *B. gibbae*; 34, ditto, *B. aquilo*; 35, ditto, *B. vijae*; 36, ditto, *B. subovatus*; 37, *B. trishae*; 38, lateral view of male genitalia of *B. dallasi*; 39, ditto, *B. gibbae*; 40, ditto, *B. aquilo*; 41, ditto, *B. vijae*; 42, ditto, *B. subovatus*; 43, ditto, *B. trishae*; 44, dorsal view of male genitalia of *B. debilipennis* (thin form); 45, ditto, *B. debilipennis* (thick form); 46, ditto, *B. sadiuae*; 47, ditto, *B. decipiens*; 48, ditto, *B. pulchellus*; 49, ventral view of male genitalia of *B. debilipennis* (thin form); 50, ditto, *B. sadiuae*; 51, *B. debilipennis* (thick form); 52, ditto, *B. decipiens*; 53, ditto, *B. pulchellus*.



FIGURES 54-70. 54, dorsal view of male genitalia of *B. majusculus*; 55, ditto, *B. josephenae*; 56, ditto, *B. amoenus*; 57, ditto, *B. nutans*; 58, ditto, *B. munitipennis*; 59, ditto, *B. macumbensis*; 60, lateral view of male genitalia of *B. majusculus*; 61, ditto, *B. josephenae*; 62, ditto, *B. amoenus*; 63, ditto, *B. nutans*; 64, ditto, *B. munitipennis*; 65, ditto, *B. macumbensis*; 66, dorsal view of male genitalia of *B. nicholasi*; 67, lateral view of male genitalia of *B. veronicae*; 68, dorsal, *B. veronicae*; 69, lateral, *B. nicholasi*; 70, lateral, *B. macropunctatus*.



FIGURES 71-74. 71, lateral view of male genitalia of *B. australiae*; 72, ditto, *B. ralphi*; 73, dorsal view of male genitalia of *B. ralphi*; 74, ditto, *B. australiae*.

Berosus stigmaticollis Fairmaire, 1879, p. 82, syn. nov.

Berosus simulans Blackburn, 1888(1889), p. 832, syn. nov.

Berosus auriceps Blackburn, 1889(1890), p. 447, syn. nov.

Berosus blackburni Zaitz, 1908 p. 358, nom. nov. for *B. auriceps*.

Types

B. approximans. Holotype, male, Peak Downs, N.T. in MNHN, seen.

B. stigmaticollis. Holotype, female, Peak Downs, N.T. in MNHN, seen.

B. ovipennis. Holotype, female, Pt Mackay, in MNHN, seen.

B. auriceps. Holotype, male, Northern Territory, in BM(NH), seen.

B. simulans. Holotype, male, Rivoli Bay, S.A. in SAM, seen.

Description (number examined 13♂)

Length 3.0–5.2 mm. Narrowly oval, elytra moderately humped, higher behind middle where it is 1/3 higher than at humeral angle. Apex of elytron rounded or produced into a small, widely triangular spine. Head black, shiny, metallic. Pronotum brown with broad central panel darker, dark portion usually not reaching front or rear edges and often with lighter area in midline, shiny. Elytron brown, with striae, punctures and a few spots, black, shiny. Ventral surface black, appendages lighter. Rugose portions of femora variable from light to dark-brown. Punctures on head strong, regular, well-impressed, most less than 1/2 puncture width apart. Punctures on pronotum similarly sized but less dense. Weaker on disc. Elytral striae well-impressed. Second stria on elytron 1/4 length of elytron. Punctures in striae and between them approximately the same size, as strong laterally as on disc. Reticulation of elytron variable, virtually absent in some, in others very strong and almost masking punctures, especially laterally. Ventral surface densely rugose punctate. Mesosternal keel strongly produced downwards forming a pillar. Front edge almost perpendicular to body, ventral edge straight, or concave in some specimens, with the front portion projecting downwards as much or further than rear portion. Lateral lobes of metacoxa raised, bluntly pointed, midline produced backwards in a point, small oval depression in midline devoid of sculpture. Keel in midline of first abdominal segment well-marked, reaching 1/4–3/4 segment. Rugose portion of metafemur 1/2–2/3 length of femur. Meso- and meta-tibiae strongly spined. Apical abdominal segment weakly and widely notched.

Male: Protarsi four-segmented, first segment moderately expanded. Head narrower than in female.

Remarks

A southern species slightly larger than *B. flindersi*. Readily separated from that species by the larger area of rugose sculpture on the femora. The notch on the last abdominal segment is also broader and weaker in *B. approximans*. Differs from *B. juxtadiscolor* and *B. reardoni* from northern Australia by having a smaller amount of rugose sculpture on the femora than in these species, in the generally strongly elytral punctures and in characters of the aedeagus. Its wide distribution, variability in size and in the strength of the dorsal punctation has led to it being described a number of times by earlier authors.

Distribution (Fig. 76)

Southern coastal Australia from Kimberley, W.A., to Rockhampton, Qld.

Berosus reardoni sp. nov.

(Figs 15, 20)

Description (number examined 7)

Length 3.2–4.5 mm. Narrowly oval, elytra moderately humpbacked, highest behind middle where it is 1.4 × height at shoulders. Apex of elytron bluntly pointed. Head shiny, black. Pronotum yellow-brown with two longitudinal black strips adjacent to midline, dark portions not reaching front or hind margin. Elytron yellow-brown with striae and many punctures on head strong, regular, well-impressed, most less than 1/2 a puncture-width apart. Punctures on pronotum moderately dense and strong laterally, weaker and sparser on disc. Dorsal surface weakly to moderately reticulate. Elytral striae well-impressed, less so on disc, second stria on elytron a little less than 1/4 length of elytron. Punctures in striae somewhat larger than those in interstriae, shallower and slightly larger laterally. Mesosternal pillar long, well-developed, ventral edge concave. Ventral surface densely rugose-punctate. Metacoxal process broad, lateral lobes lowered slightly, diverging towards rear, deeply and broadly pitted in centre, weakly triangularly produced backward in midline. Apical abdominal segment notched. Rugose portion of metafemur 2/3 length of femur, that of mesofemur between 1/2–2/3, that of profemur about 1/3 length of femur on hind edge.

Male: Protarsi four segmented. First segment moderately expanded.

Remarks

This northern member of the *approximans* species group closely resembles *B. juxtadiscolor*, but differs in being lighter in colour, particularly the rugose portions of the femora, and in the shape of the aedeagus and parameres.

Distribution (Fig. 75)

Northern N.T.

Types

Holotype male 'Katherine, N.T., at light 9.11.68 J. A. L. Watson', in ANIC.

***Berosus juytadiscolor* sp. nov.**
(Figs 14, 19)

Description (number examined 18)

Length 3.5–5.0 mm. Narrowly oval. Elytra weakly humpbacked, highest behind middle where it is $1.2 \times$ height at shoulder. Apex of elytron rounded. Head shiny black. Pronotum dark yellow-brown with two central longitudinal stripes darker. Elytron darkish yellow-brown with punctures and striae darker, in many individuals elytron almost completely dark. Ventral surface dark-brown, appendages other than rugose portion of femurs somewhat lighter. Punctures on head strong, regular and well-impressed, most less than $1/2$ a puncture-width apart. Punctures on pronotum moderately dense and strong laterally, weaker and sparser on disc. Dorsal surface weakly to moderately reticulate. Elytral striae well-impressed, less so on disc. Second stria on elytron a little less than a $1/4$ length of elytron. Punctures in striae slightly larger than those in interstriae. Punctures stronger towards sides. Interstriae not arranged in a single row. Mesosternal pillar long, well-developed, ventral edge slopes downwards towards rear, sharply pointed on ventral rear angle. ventral surface densely but shallowly rugose-punctate. Metacoxal process broad, squarish, lateral lobes weakly lowered, deeply and broadly pitted in centre, triangularly produced backwards in midline. Midline keel in first abdominal segment moderately developed in front half. Apical abdominal segment notched. Rugose portion of metafemur $2/3$ length of femur, that of mesofemur a little over $1/2$, that of profemur about $1/3$ on hind edge.

Male: Protarsi four-segmented. First segment moderately expanded, second segment small; third segment long and thin about length of first and second segment.

Remarks

This species closely resembles *B. reardoni* but has a more complexly shaped paramere and differently shaped aedeagus. It seems to be a darker species than *B. reardoni* which has the rugose portions of the femora the same colour as rest of leg. Only a few specimens of *B. reardoni* are known. A clearer idea of the relationships between these two species must await the collection of further material. The greater extent of rugosity on the legs separates it from the otherwise quite similar *B. discolor*.

Types

Holotype, male, '11 09'S 132 09'E, Black Point, Cobourge, N.T., 15–23 Feb., 1977. J. A. Weir', in

ANIC. Paratypes; six, same data as holotype, in ANIC; one, same data as holotype, in CW; two, 'Howard Springs, N.T., light 27.1.68, J. A. L. Watson', in ANIC.

Distribution (Fig. 77). At present known only from the coastal areas of the N.T.

***Berosus timmsi* sp. nov.**
(Figs 16, 21)

Description (number examined seven)

Length 3.4–4.0 mm. Oval, elytron weakly humped, highest behind middle where it is approximately $1.2 \times$ height of shoulder. Apex of elytron rounded or weakly truncated. Head black, shiny, metallic. Pronotum yellowish with central panel dark-brown, shiny, metallic. Elytron shiny yellow-brown, with striae, punctures and a few spots black. Ventral surface dark-brown to black, appendages brown except for rugose portions of meso and metafemura which are darker. Punctures on ventral surface moderately large, dense. Punctures on head strong, regular, well-impressed, most at rear of head less than $1/2$ puncture-width apart. Punctures on pronotum strong, variable in size particularly laterally, less dense than on head, well-impressed. Elytral striae well-impressed, with strong tendency for the inner edge of striae to be sharper than outer. Second stria on elytron $1/4$ length of elytron. Punctures in striae strong and little larger than largest on pronotum. Interstitial punctures small, subobsolete over most of elytron. Mesosternal keel moderately developed, pillar well-developed, concave and denticulate on ventral edge. front and rear projections largest. Metacoxal process projecting backwards in midline, lateral lobes weakly raised, pointed behind, weakly converging towards front, a wide shiny diamond shaped depression in midline. Keel in midline of first abdominal segment moderately strong reaching across most of segment. Rugose portion of metafemur approximately $2/3$ length of femur, that on mesofemur approximately $1/2$, that on profemur $1/2$ – $1/3$ length of femur. Meso- and metatibiae strongly spined. Apical abdominal segment with strong deep wide notch to about $1/2$ distance of normally visible portion of segment.

Male: Protarsi four-segmented. First segment strongly expanded. Metafemur with distinct triangular bulge in lower hind margin midway along rugose portion.

Female: Metafemur of some specimens show slight thickening in same area as in male.

Remarks

This species resembles the more widespread *B. juytadiscolor* with which it is sympatric, but differs from it (and all other *Berosus*) by the shape

of the male metafemur which is reminiscent of the femora of some male Dytiscids of the genus *Antiporus*. The variably-sized pronotal punctures and very small interstitial punctures also separate it from *B. juxtadiscolor* and *B. reardani*.

Distribution (Fig. 82)

Known only from the type locality at the tip of Cape York, Qld.

Types

Holotype, male, 'Banjaga, Qld, 29/6/83, Timms', in SAM. Seven paratypes, same data as holotype; one male, one female, in ANIC; one male, three females in CW.

Berosus niger sp. nov.

(Figs 25, 30)

Description (number examined seven)

Length 3.3–4.0 mm. Oval. Elytra parallel-sided, humpbacked, highest just behind the middle where it is 1.5 × the height at the shoulders. Apex of elytron not spined. Black, portions of elytral interstriae in apical half and appendages of head, dark yellow-brown. Head and pronotum with large, dense, moderately-impressed punctures. Pronotum with some scattered much smaller punctures in spaces between larger punctures. Strial punctures large, shallow. Interstitial punctures weak, ill-defined, lacking laterally and apically. Second striae approximately 1/2 length of elytron. Spaces between elytral striae 8 and 9, 9 and 10, and 10 and 11 greater in the middle of elytron than elsewhere. Elytral striae 1, 3, 4, 5, 6, 7, 8 and 11 ridged, pronouncedly so on stria 8. The strongly-ridged stria 8 bends sharply towards apex where it is about 90° in the edge of elytron when viewed laterally. Ventral surface rugose-punctate. Mesosternal pillar long, ventral edge weakly concave, anterior ventral angle with very small spine. Metacoxal process broad, squarish, with large pit in midline; projecting backwards sharply in midline, continued forwards in midline by well-marked ridge. Midline keel on first abdominal segment strongly raised for whole length of segment. Apical abdominal segment moderately notched, lateral flanges moderately developed. Rugose portion of metafemur reaching 1/2 way on posterior edge and a little less on anterior edge; rugose portion of mesofemur about 1/3 length of femur, that on profemur very small.

Male: Protarsi four-segmented. Basal segments not expanded, first segment somewhat longer than second and third which are subequal in size.

Remarks

A north-eastern highlands species. Readily separated from similar species by the almost completely

black colour and the form of the lateral striae on the elytron.

Distribution (Fig. 75)

Mountainous areas on east coast north of Townsville, Qld.

Types

Holotype, male, 'Star Valley lookout c. 5 km W of Paluma Qld, 3.vii.67, at light, J. G. Brooks', in ANIC. Paratypes: one, '13.6M up Whitfield Ra. Rd., Cairns, 3/11/70, J. G. Brooks', in ANIC; one, 'Tinaroo Ck., N.Q. 1/73 A.W.H.', in ANIC; one 'Mt. Spec. N.Q. 11/73 G.B.', in ANIC; one, '7.8M. NW Paluma, NQ 5.11.73 J. G. Brooks, in ANIC; two, 'Australia N.Qld. Windsor Tableland via Mt. Carbine 11–12 Jan 1980 R. I. Store', in QPI.

Berosus involutus (W. MacLeay)

(Figs 9, 26, 31)

Hygrotraphus involutus W. MacLeay, 1873 p. 132.

Types

There are four specimens from Gayndah, Qld in ANIC (on loan from the MacLeay Museum), labelled 'Syntypes'. Two of these are *B. pulchellus* and two *B. approximans*. The original description does not indicate how many specimens MacLeay had before him. Apart from the locality there is little to connect these insects with a type series of *B. involutus*. Two specimens labelled '*Hygrotraphus involutus* M. L. W. Gayndah', mounted on the same card, are in the AM labelled 'Holotype' and numbered K19531. They agree well with the brief description and belong to the species that subsequent workers such as Blackburn and Lea have identified as *B. involutus*. I therefore herein designate the left-hand specimen as the lectotype of *Hygrotraphus involutus* W. MacLeay, 1873.

Description (number examined 475)

Length 3.5–4.5 mm. Oval, elytra humpbacked, highest just behind middle where about 1.5 × height at shoulder. Apex of elytron rounded. Head and most of pronotum black, with metallic sheen. Front and side margins of pronotum yellow-brown, occasionally lacking, elytron brown, punctures and striae and variable number of markings black. Ventral surface black. Appendages light-brown, tip of labial palpi and rugose portions of meso- and metafemora black. Head and pronotum with dense large evenly-sized nearly confluent punctures. Interstitial punctures on elytron large and well-marked, almost touching, those towards sides and humeral angles larger and squarer. Interstitial puncture small, shallow, strongest on disc, obsolete laterally. Second stria approximately half length of

elytron. Distance between striae seven and eight and eight and nine often slightly greater in middle, other striae approximately equidistant from each other. Ventral surface rugose-punctate. Mesosternal keel in form of a long pillar, with a small downward point at front edge. Metacoxal process broad, sides raised, subparallel, deeply and broadly pitted in middle, pit devoid of sculpture, projecting backward sharply for short distance in midline, lobed. Midline keel of first abdominal segment strongly raised for whole width of segment. Apical abdominal segment broadly notched with well-developed lateral flanges, a pair of very small tubercles on edge of middle of notch. Rugose portion of metafemur dark, reaching $1/2$ – $2/3$ along femur on anterior edge, not as far on posterior edge.

Male: Protarsi four-segmented. Segments not expanded, basal three subequal in size.

Remarks

A common species in clear streams and pools in the Great Dividing Range from Vic. to north Qld. Many specimens from the higher areas of Vic. and N.S.W. are darker in colour and lack the distinctive yellow margins on the pronotum. Separated from the two related species, *B. niger* and *B. arcus*, by the lack of strongly raised and bowed seventh elytral stria. It is also noticeably larger than *B. arcus* and is different in colour from *B. niger*. It is only in the northern portion of its range that *B. involutus* is sympatric with these two similar species.

Distribution (Fig. 76)

Coastal eastern Australia from southern Cape York to south-eastern Vic.

Berosus arcus sp. nov. (Figs 8, 24, 29)

Description (number examined 149)

Length 1.5–3.4 mm. Oval, elytra humpbacked, highest just behind middle where about $1.2 \times$ height at shoulder. Apex of elytron without spines. Black, elytral interstriae, edges of pronotum apart from central portion of rear margin, appendages apart from tip of labial palpi and rugose portions of meso and metafemora yellow-brown. Head and pronotum with dense strong evenly-sized and spaced punctures. Strial punctures on elytron large, almost touching. Interstitial punctures large but very shallow, stronger on disc than laterally. Second stria on elytron approximately $1/2$ length of elytron. Distance between striae eight and nine greatly enlarged in middle to about twice distance between striae nine and ten, which is also slightly enlarged in middle. Stria eight moderately carinate in middle section where distance from stria nine greatest. Ventral surface rugose-punctate. Mesosternal keel in wide pillar, anterior ventral angle of pillar sharply

produced downward into small sharp point. Metacoxal process broad, squarish, sides raised, subparallel, deeply and widely pitted in midline, projecting backwards sharply in midline. Midline keel on first abdominal segment strongly raised for whole length of segment. Apical abdominal segment broadly notched with well-developed lateral flanges. Rugose portion of metafemur reaching nearly $2/3$ along posterior edge of femur and $1/3$ on anterior edge, that on mesofemur reaching a little over $1/2$ length of femur on posterior edge, $1/3$ on anterior edge, that on profemur $1/3$ on posterior edge and less than $1/4$ on anterior edge.

Male: Protarsi four-segmented, basal three segments subequal in size.

Remarks

A northern species confined to the streams and riverside pools of the ranges around and to the north of the Atherton Tableland. Smaller than *B. involutus* and *B. niger* and readily separated from them by colour and the form of the eighth elytral stria.

Distribution (Fig. 79)

Ranges of southern Cape York and Atherton Tableland, Qld.

Types

Holotype, male, '5 mi. N. Bloomfield Rn., N.Q. 7-9. May 1970 S. R. Curtis', in ANIC. Paratypes, 11 same data as Holotype, in ANIC; one same data, in CW.

Berosus trishae sp. nov. (Figs 37, 43)

Description (number examined 39)

Length 2.4–4.5 mm. Oval. Elytra parallel-sided, humpbacked, highest just behind middle where it is $1.2 \times$ higher than at shoulders. Apex of elytron rounded. Yellow-brown, head, three rough broad longitudinal patches on pronotum, about a dozen small patches on elytron and vague areas of ventral surface darker. Head and pronotum moderately covered with large strong punctures. A single even row of slightly smaller punctures along front and rear edges of pronotum. Strial punctures on elytron very large, almost confluent, strongest laterally where they are almost square. Interstitial areas shiny lacking punctures except apically in interstria 3. Second elytral stria a little more than $1/2$ length of elytron. Interstitial areas raised somewhat towards apex of elytron. Ventral surface moderately punctate. Mesosternal keel produced in robust pillar, ventral edge of pillar convex. Metacoxal process very broad, parallel sided, central portion with wide pit, lateral lobes project downwards at about 35° , narrowly and triangularly produced backwards in

midline. Midline keel on first abdominal segment strongly raised for whole length of segment. Apical abdominal segment widely and deeply notched with well-developed lateral flanges. Rugose portion of metafemur about 2/3 length of femur, that on mesofemur 1/2-2/3, and that on profemur about 1/2 length of femur.

Male: Protarsi four-segmented, basal segments not expanded.

Remarks

A northern species. Separated from the quite similar *B. quadripunctatus* by the greater extent of rugose sculpture on the femora and characters of the aedeagus. The sculpture on the head is a little rougher than in *B. quadripunctatus* and the punctures on pronotum and elytra are smaller. Although this size difference is clearly evident in direct comparisons of most specimens, I have been unable to quantify it to enable the character to be used to separate the species. Most specimens are < 3.5 mm long but a female from Charters Towers, Qld., in NSW, is considerably larger at 4.5 mm. I can detect no other difference from N.T. specimens.

Distribution (Fig. 80)

Darwin area, N.T., Atherton Tableland and, Charters Towers Qld.

Types

Holotype, female, 'N.T. Lake Bennett area c. 25 km S.E. of Manton Dam 29-30 Dec. 1979, M. B. Malpatil', in NTM. Paratypes, 20, 'N.T., Ck. in Holmes Jungle 13.1.1980 M. Malapatil', in NTM, two same data in CW.

Berosus macropunctatus sp. nov.

(Fig. 70)

Description (number examined two)

Length 3.0-3.6 mm. Oval. Sides of elytra subparallel, humpbacked, highest about 1/3 distance from apex of elytra where it is about 1.2 x height at shoulders. Apex of elytron squarish. Yellow-brown, head and pronotum black except for narrow yellowish band on lateral and hind edges, elytron with scattered darker patches. Head and pronotum strongly rugose-punctate. Strial punctures on elytron large, larger and squarish towards sides. Interstrial areas shiny, impunctate except for a row of very small setae-bearing punctures towards apex of third interstria. Lateral three interstrial areas raised into weak ridges. Interstrial areas at extreme apex weakly raised. Ventral surface strongly rugose-punctate. Mesosternal keel produced into a narrow pillar. Ventral edge of pillar slopes downwards towards rear and has a small downward pointing

spine on ventral anterior angle. Metacoxal process very broad, lateral lobes parallel sided, rather narrow, separated by wide pit in centre of process, open towards rear, lateral lobes slope downwards at about 20°, broadly triangularly produced backwards in midline. Midline keel of first abdominal segment strongly developed over whole length of segment, ventral edge serrate. Apical abdominal segment deeply and widely notched with well-developed lateral flanges. Rugose portion of metafemur 3/4 length of femur, that of mesofemur a little less than 3/4, that on profemur 1/2 length of femur.

Male: Protarsi four-segmented, basal segments not expanded.

Remarks

A distinctive species readily separated from *B. irishae* and *B. quadripunctatus* by the strongly rugose-punctate black head and pronotum.

Distribution (Fig. 76) (N.T. type localities only.)

Types

Holotype, male, 'Burrell's Ck Stuart H'way N.T. 24 Nov. 1972 D.H. Colless', in ANIC. Paratype, one, 13°15'S, 131°06'E, Adelaide River, N.T., 16.x.72. M. S. Upton', in ANIC.

Berosus quadripunctatus sp. nov.

Description (number examined 4)

Length 3.2-3.9 mm. Elytra humpbacked, highest just behind middle where it is 1.3 x height at shoulders. Apex of elytron rounded, weakly flanged. Yellow-brown with head black and three broad vague longitudinal patches on pronotum, scattered patches on elytron and patches in the midline ventrally, darker, shiny. Head and pronotum moderately covered with large well-impressed punctures. Elytron with stria punctures very strong, particularly laterally where they are square. Punctures in adjacent lateral striae almost touch. Interstrial areas shiny, lacking punctures except for some minute setae-bearing ones towards apex in interstria three. Second elytral stria reaches a little over 1/2 length of elytron. Interstrial areas towards extreme apex become strongly raised. Ventral surface covered with numerous large but separate rugose punctures. Mesosternal keel produced into a narrow pillar, concave on ventral edge. Metacoxal process very broad, parallel-sided with large pit in midline, narrowly triangular, projecting backwards in midline, lateral lobes slope downwards at about 45°. Keel on first abdominal segment strongly raised for whole length of segment, serrate on ventral edge. Apical abdominal segment broadly notched, with

well-developed lateral flanges. Rugose portion of metafemur a little over 1/2 length of femur, that on mesofemur a little under 1/2, that on profemur 1/3 length of femur.

Male: Protarsi four-segmented, basal segments not expanded.

Remarks

A little known species differing from *B. trishae* by the less well-developed rugose sculpture on the femora and in the more uniform sculpture on head. A female specimen from Charters Towers, Qld., (in NSWDA) may belong to this species. It is longer (4.5 mm), the rugose portion on the femora is a little greater, the sculpture on the head is rougher with some scattered very small punctures as in *B. trishae*. In these characters it is intermediate between *B. trishae* and *B. quadrapunctatus*.

Distribution (Fig. 80)

Known only from the type series from McArthur River, N.T.

Types

Holotype, male, 'McArthur River, 16°47'S 135°45'E, 14 km S by W of Cape Crawford, N.T., 25 Oct. 1975 M. S. Upton, in ANIC. Paratypes, three, same data as holotype, in ANIC.

Berosus queenslandicus Blackburn (Figs 23, 28)

Berosus queenslandicus Blackburn, 1898, p. 223.
Berosus quartinus d'Orchymont, 1943, p. 6, syn. nov.

Types

B. queenslandicus, holotype female, Qld., in BM(NH), seen. Paratype, female damaged, in SAM, seen. *B. quartinus*, holotype, male, and paratype, in MNHN.

Description (number examined 42)

Length 4.2–6.3 mm. Oval, elytra humpbacked, approximately twice as high just behind middle as at shoulder. Apex of elytron rounded. Head black with metallic sheen. Pronotum shiny, widely black or dark-brown in midline, brown at sides. Elytron shiny, brown with dark-brown to black mottlings. Ventral surface mottled dark-brown and black, appendages brown, apical segment of labial palpi darker, rugose portions of meso- and meta femora dark-brown to black. Punctures on head large, subequal except for clypeal margin where they are smaller, those on disc separated by about 1/2 their width, a few scattered very small punctures in some specimens. Head with small midline ridge on back, sometime lacking. Punctures on pronotum as on head, closer together laterally. Punctures in elytral

striae well-marked almost confluent in any one stria, stronger towards front. Interstrial areas virtually impunctate except for small area of large punctures on humeral angles. In some specimens some very shallow small punctures can be seen in some lights in interstriae on disc. Striae weakly impressed on disc, stronger laterally and apically. Second stria on elytron reaching 2/3 length of elytron. Striae approximately equidistant from each other. Ventral surface rugose-punctate. Mesosternal keel in form of high narrow pillar, ventral edge concave, keel on midline of mesosternum forward of pillar weak. Midline keel on first abdominal segment well-marked, reaching almost completely across segment but weakening rapidly towards rear. Metacoxal process broad with well-marked lateral lobes, sides subparallel, with depressed shiny impunctate area in midline. Rugose portion of metafemur about 1/3 length of femur, ending in relatively straight edge across most of femur, that on metafemur 1/3, that on profemur 1/3 length of femur on hind edge. Apical abdominal segment deeply notched in midline with lateral flanges to notch.

Male: Protarsi four-segmented, basal segments subequal not expanded.

Remarks

Separated from the superficially similar *B. duplopunctatus* by the slightly larger and differently shaped rugose portions on femora, the virtual lack of smaller punctures on head and pronotum and the virtual lack of interstrial punctures. Some specimens have some minute punctures in between the large ones on the head and to a lesser extent on the pronotum, but these are much smaller and fewer than those in *B. duplopunctatus*. Synonymy based on d'Orchymont's description and illustration of male genitalia.

Distribution (Fig. 78)

Coastal south-eastern Australia from Caloundra, Qld., to Adelaide, S.A.

Berosus duplopunctatus Blackburn (Figs 22, 27)

Berosus duplopunctatus Blackburn, 1888 (1889), p. 828.

Types

Holotype, female, Pt Lincoln, S.A. in BM(NH), seen. Paratype, female, Pt Lincoln, S.A. in SAM, seen.

Description (number examined 109)

Length 4.5–6.4 mm. Oval, elytra humpbacked, at highest point just behind middle about 1.5 × height

at shoulder. Apex of elytron rounded. Head relatively wide, black, shiny with metallic sheen. Midline of pronotum black, sides brown. Elytron predominantly brown with punctures outlined in black plus some black spots, extent of black varies between specimens and is the dominant colour in many. Ventral surface black, appendages light-brown, tip of apical segment of labial palpi black, rugose portions of meso- and metafemora black. Head densely punctate with both large and small punctures. Pronotum with large and small punctures, less dense than on head. Punctures in elytral striae well-impressed, almost confluent, stronger towards front, about as strong on disc as laterally. Interstitial punctures shallow, small, numerous, scattered, very weak laterally. Striae moderately impressed, slightly weaker on disc. Striae approximately equidistant apart. Second stria on elytron reaches to 3/4 length of elytron. Humeral angle of elytron serrate due to large punctures close to edge. Ventral surface strongly rugose-punctate. Mesosternal keel in form of high narrow pillar, weakly concave on ventral edge, keel in front of pillar weak. Midline keel on first abdominal segment well-marked in front half, weaker in hind half of segment. Apical abdominal segment deeply notched, notch with lateral flanges. Metacoxal process with well marked lateral lobes, converging towards rear and with small shiny impunctate depressed area in midline. Rugose portion of mesofemur about 1/3 length of femur on hind edge, about 1/4 length on front edge of femur, that on hind edge of metafemur 1/4, that on profemur 1/4 length of femur.

Male: Protarsi four-segmented, basal three subequal not expanded.

Remarks

Readily separated from the superficially similar *B. queenslandicus* by the punctate elytral interstriae and the presence of small punctures on the pronotum.

Distribution (Fig. 80)

Coastal eastern Australia from Sydney; N.S.W. to Kangaroo Island, S.A.; Tas.

Berosus nutans (W. Macleay)

(Figs 5, 57, 63)

Hygrotrichus nutans W. Macleay, 1873, p. 132.

Berosus pullidulus Fairmaire, 1879, p. 81, syn. after Blackburn, 1898, p. 222.

Types

Two syntypes labelled 'Gayndah' and mounted on the same card are in the ANIC. The left-hand side specimen, a female, is here designated as lectotype.

Description (number examined 440)

Length 4.2-8.8 mm. Elongate oval, not humpbacked. Apex of elytron rounded or obliquely truncated. Dorsal surface brown with vague darker markings particularly on head and pronotum. Elytron with striae darker. Ventral surface dark-brown to black, appendages brown to dark-brown except for darker tip of labial palpi. Apex of abdomen occasionally brown. Punctures on head well-marked, weaker towards front, transversely elongate. Sculpture on pronotum consists of a close network of fine transverse grooves which cover most of the surface, all but obscuring punctures which themselves tend to be transversely elongate as on head. A fine reticulation is also present on some specimens. Scutellum sculptured as pronotum. Elytron with striae lacking or only weakly impressed, their position often outlined by rows of small transversely expanded, darkly pigmented spots. Elytron densely and evenly covered with short rather stout setae, each seta arising from a small shallow transverse groove. Ventral surface shallowly rugose-punctate with small setae arising from each puncture. Mesosternum with weak keel in midline, extended quite strongly backwards between meso-coxae. Midline of first abdominal segment with moderate keel in front 1/4. Metacoxal process raised, sharply triangular with elongate oval area in midline devoid of sculpture. Rugose portion of metafemur 3/4 length of femur, that of mesofemur 2/3, that of profemur 1/2 length of femur.

Male: Protarsi four-segmented, basal segment expanded, about as long as second and third segment combined, second segment expanded, same length as simple third segment.

Remarks

A common and widespread inland species, readily recognised by the unique sculpture of the pronotum.

Distribution (Fig. 78)

Coastal and southern inland Australia.

Berosus pulchellus W. S. Macleay

(Figs 48, 53)

Berosus pulchellus W. S. Macleay, 1825, p. 35.

Hygrotrichus devisi Blackburn, 1898, p. 225, syn. after d'Orchymont 1943, p. 421.

Types

B. pulchellus, Java, location unknown. *B. devisi*, holotype, ? female, Qld., in BM(NH), seen.

Description (number examined 233)

Length 2.8-4.8 mm. Elongate oval, elytra not humpbacked. Apex of elytron rounded. Head

black, shiny. Pronotum light-brown with front edge narrowly black and usually with wide central panel black, black area not reaching rear border and often with portion of midline narrowly light-brown. Elytral striae often darker. Ventral surface black, appendages light-brown except extreme apex of labial palpi which is darker. Head evenly punctate with moderately dense small punctures, punctures somewhat weaker towards front. Pronotum moderately and evenly covered with small punctures. Elytron strongly and evenly covered with similarly sized punctures, each puncture with a well-marked seta. Elytral striae lacking or very weakly impressed. Punctures in elytral striae same size as interstitial punctures and difficult to distinguish from them. Ventral surface evenly, shallowly rugose-punctate. Midline of prosternum with weak but well-marked keel, weakly projecting backwards between mesocoxae. Midline of first abdominal segment weakly raised in front half. Metacoxal process bluntly triangular, raised, midline with narrow oval area devoid of punctures. Apical abdominal segment deeply notched. Rugose portions of meta and mesofemora $3/4$ length of femura, that on profemur $2/3$ – $3/4$ length of femur.

Male: Protarsi four-segmented, basal two segments moderately expanded, basal segment about twice length of second which is about same length as third.

Remarks

This widespread and common species is readily separated from all other Australian *Berosus* by the small size, black head and virtual lack of elytral striae. It is most commonly collected from the sandy pools formed during the dry season in the beds of the major northern and eastern river systems. It has recently been collected in numbers in sewerage settlement pits at Whyalla, S.A., an unusual habitat and a long way from its normal range.

Distribution (Fig. 82)

Tropical Australia; Whyalla, S.A.; Asia.

Berosus dallasae sp. nov.

(Figs 32, 38, 70)

Description (number examined 80)

Length 3.8–6.8 mm. Elongate oval. Elytra not humpbacked. Head and pronotum shiny, elytron rugosely reticulate. Apex of elytron produced into two spines, outer one usually strongly and widely developed, inner often small or even vestigial. Dorsal surface light yellow-brown, rough patches on head, pronotum and elytron darker, elytron stria darker. Ventral surface dark-brown, appendages lighter, tip of labial palpi dark. Head evenly and strongly punctate, punctures much larger than eye facet, much weaker towards front. Pronotum evenly

punctate with large strong regular punctures except for some smaller areas along front and rear margin. Punctures on disc have a tendency to become longitudinally elongate. Elytral striae strongly impressed. Stria 2 with punctures a little smaller than those on pronotum and about twice size of those in adjacent interstriae. Interstitial punctures evenly, densely but shallowly impressed over whole elytron, each puncture bearing a small seta. Ventral surface rugose-punctate. Midline of mesosternum weakly and broadly carinate, moderately projected backwards. Midline of first abdominal segment weakly carinate in front $1/4$. Metacoxal process broadly triangular, midline weakly carinate in front of a small diamond-shaped area in centre, devoid of sculpture and bounded on front sides by weak edges. Rugose portion of metafemur $3/4$ length of femur, that on mesofemur $2/3$ – $3/4$ that on profemur $1/2$ – $2/3$ length of femur.

Male: Protarsi four-segmented. Basal two segments moderately expanded, first segment about $1.5 \times$ length of second which is a little larger than the narrow third segment.

Remarks

This widespread species of northern Australia is readily separated from the two other, equally widespread, species with setose elytral punctures, by the lack of strongly transversely elongate pronotal punctures (from *B. nutans*), and lack of a black head (from *B. pulchellus*).

Distribution (Fig. 75)

Tropical Australia.

Types

Holotype, male, '1 km N. of Millstream, W.A. (21°35'S 177°04'E), 9–10.iv.1975, M. S. Upton', in ANIC. Paratypes, nine same data as holotype, in ANIC; one same data as holotype, in CW.

Berosus macumbensis Blackburn

(Figs 59, 65)

Berosus macumbensis Blackburn, 1896, p. 259.

Types

Holotype, male, Macumba Creek, S.A. in BM(NH), seen.

Description (number examined 150)

Length 5.6–7.8 mm. Elongate oval, not humpbacked. Apex of elytron with two spines, the inner usually small and the outer as long as the distance between the two spines. Elytra shiny. Dorsal surface light brown to brown with dark mottlings. Elytral striae and punctures on disc darker. Ventral surface dark-brown to black. Appendages brown except for extreme tip of labial palpi which



75

- *B. majusculus*
- ▲ *B. vijae*
- △ *B. dallasae*
- *B. niger*
- ◆ *B. reardoni*



76

- *B. involutus*
- *B. macropunctatus*
- ▲ *B. josephenae*
- *B. approximans*



77

- *B. australiae*
- ▲ *B. juxtadiscolor*
- *B. ralphi*



78

- *B. nutans*
- ▲ *B. gibbae*
- △ *B. decipiens*
- ◇ *B. queenslandicus*

FIGURES 75-78. Distribution maps for Australian *Berosus* spp.



79

- *B. arcus*
- *B. discolor*
- △ *B. sadiæ*
- ◇ *B. aquilo*
- ▲ *B. nicholasi*



80

- *B. debilipennis*
- ▲ *B. duplopunctatus*
- *B. quadropunctatus*
- *B. trishae*



81

- ▲ *B. munitipennis*
- *B. macumbensis*
- △ *B. veronicae*
- ◆ *B. subovatus*



82

- *B. pulchellus*
- *B. aemoenus*
- △ *B. timmsi*

FIGURES 79-82. Distribution maps for Australian *Berosus* spp. (cont.).

is darker. Head strongly and evenly punctate except towards front where punctures are considerably smaller and weaker. Punctures on pronotum uneven in size and often with a rather patchy distribution. A row of very small punctures along front and rear margins. Elytral striae weakly impressed, for the most part reduced to a row of well-impressed punctures about the size of the larger punctures on pronotum. Interstitial punctures on disc markedly smaller than those on sides of elytra; in no case is there a tendency for interstitial punctures to form a single row. Interstitial punctures on disc tend to be uneven in size. Underside densely rugose-punctate. Midline of mesosternum with weak rather rounded keel, projecting a little distance backwards. Midline of first abdominal segment with little or no keel. Metacoxal process raised, triangular, a narrow diamond or oval-shaped area devoid of sculpture in the midline. Rugose portion of metafemur $1/2$ to $2/3$ length of femur, that on mesofemur a little over $1/2$ and on profemur $1/3$ to a $1/2$ length of femur.

Male: Protarsi four-segmented, basal two segments expanded, basal segment larger than second; second and third segment subequal in length.

Remarks

A widespread inland species readily recognized from the other large *Berosus* by the pattern of punctuation on the elytra, where the outer punctures are much stronger than the inner punctures.

Distribution (Fig. 81)

Inland Australia.

Berosus munitipennis Blackburn

(Figs 3, 58, 64)

Berosus munitipennis Blackburn, 1895, p. 30.

Type

Holotype, ♀ male, Lake Callabonna, S.A., in BM(NH), seen.

Description (number examined 48)

Length 4.8–6.6 mm. Elongate oval, not humpbacked. Apex of elytron with very long narrow outer spine and short inner spine, outer usually longer than distance between spine bases. Light-brown, pronotum and head slightly darker than elytra. Suture lines and some punctures usually black on elytron disc. Ventral surface dark-brown to black; appendages brown, tip of labial palpi darker. Head moderately to quite densely covered with punctures, large and well-marked in basal half, smaller towards front. Elytron shiny or with weak

to moderate reticulation. Pronotum sparsely or moderately and rather unevenly covered with variably sized, well-marked punctures, front and rear margins with only a few shallow small punctures. Elytral striae weakly to moderately impressed, often reduced over much of disc to a row of punctures. Serial punctures about same size as larger ones on pronotum. Interstitial punctures sparse, shallow, lacking completely over much of elytra in some specimens, where present tend to be arranged in single row. Second elytral stria less than $1/4$ length of elytron. Ventral surface shallowly rugose punctate. Midline of mesosternum weakly carinate, weakly extended backward. Midline of first abdominal segment weakly carinate in basal $1/2$ or $1/4$. Metacoxal process triangularly-raised, with patch in midline without sculpture, patch bounded at rear by a slight V-shaped ridge extended backwards in midline to tip of process. Rugose portion of metafemur $1/3$ – $2/3$ length of femur, that of mesofemur $1/4$ – $1/2$, that on profemur $1/3$ length of femur along ventral edge.

Male: Basal two segments of protarsi moderately expanded. First segment about $2 \times$ length of second, which is about the same length as the third.

Remarks

An inland species readily recognized by the long, thin, outer elytral spines and virtual lack of an inner one, and the weak development of sculpture on the elytra. This latter character tends to be more marked in central and northern specimens compared with those from Vic. The contrast of the pale upper side and black ventral surface in most specimens is quite striking. The extent of rugosity on the femora is particularly variable in this species.

Distribution (Fig. 81)

Inland Australia south of Barrow Creek, N.T.

Berosus amoenus sp. nov.

(Figs 56, 62)

Distribution (number examined nine)

Length 3.3–4.5 mm. Elongate oval. Weakly reticulate in some specimens. Elytra not humpbacked. Apex of elytron truncated, spines vestigial. Dorsal surface dark-brown to black, edges of pronotum and elytron yellow-brown, sides of elytron with three pale patches extending inwards from sides, the apical ones more distinct. Disc of elytron variegated yellow and brown-black. Ventral surface dark-brown, appendages a little lighter, apex of labial palpi dark-brown. Head sparsely covered with strong punctures, about $1.5 \times$ size of eye facet, those towards front much smaller. Pronotum moderately but unevenly covered with strong punctures, a little larger than those on head, punctures tending to be

elongate longitudinally, a few isolated smaller punctures along front and rear margins, elytral striae moderately to strongly impressed. Second stria on elytron with 11 to 16 punctures. Punctures in striae, between striae and on pronotum subequal in size. Interstitial punctures lateral to stria 9 approximately arranged in one line. Ventral surface rugose-punctate. Midline of mesosternum weakly raised, moderately projecting backwards. Midline of first abdominal segment weakly carinate in front 1/4. Metacoxal process raised, triangularly produced backwards with a short narrow keel in midline at extreme rear and small narrowly oval area in middle devoid of sculpture. Rugose portion of metafemur $2/3 \times$ length of femur, that of mesofemur $1/2-2/3$ that of profemur $1/4-1/2$ length of femur.

Male: Protarsi four-segmented, basal two segments broadly expanded, basal longer than second which is a little longer than the small third segment. Apical abdominal segment entire.

Remarks

A rare species from coastal N.T., readily recognised by the black head and predominantly black pronotum. The size and black head resemble the *B. approximans* group of species but the unlobed metacoxal process and lack of mesosternal pillar separate it from that group.

Distribution (Fig 82)

Coastal N.T.

Types

Holotype, male, '12°52'S, 132°50'E Kuongarra, 15 km E of Mt. Cahill, N.T. 15.xi.1972, M. S. Upton', in ANIC. Paratypes: two, '16°28'S, 136°09'E 46 km SSW of Borroloola, N.T. 28 Oct. 1975, M. S. Upton', in ANIC; six, 'King River N.T. W. McLennan Pres. H. L. White 17.10.16', in NMV.

Berosus josephenae sp. nov.

(Figs 55, 61)

Description (number examined 19)

Length 5.5–6.0 mm. Elongate oval. Elytra not humpbacked. Apex of elytron weakly to quite strongly produced backwards, ending in two spines, the outer well-developed, the inner much less so. Dorsal surface light-brown, with patches on head, centre of pronotum, elytron, inner striae and punctures on elytron darker. Ventral surface dark brown-black, appendages lighter, rugose portions of meso and metafemora and tip of labial palpi dark brown-black. Head strongly punctate, punctures larger than eye facets, punctures weakening towards front. Pronotum strongly densely and evenly punctate, punctures of one size except for a few smaller ones

on extreme front and rear edges. Elytral striae strongly impressed. Stria 2 with 15 to 23 punctures about size of those on pronotum and 1.5 to 3 \times size of those in adjacent interstitial area. Interstitial punctures relatively large, uniform in size, well impressed, arranged in more than one row over most of elytron, larger but shallower towards sides. Ventral surface strongly rugose-punctate. Midline of mesosternum weakly to moderately carinate, moderately projected backwards. Midline of first abdominal segment raised in front third. Metacoxal process raised, triangularly produced backwards, weakly ridged in midline except for a broadly diamond-shaped area in centre which is devoid of sculpture. Rugose portion of metafemur $2/3-3/4$ length of femur, that of mesofemur $1/2-2/3$, that of profemur about $1/2$ length of femur.

Male: Protarsi four-segmented, basal segments moderately expanded, basal segment much longer than second segment which is about same length as much narrower third segment. Apical abdominal segment entire.

Remarks

As yet known only by a few specimens from coastal N.T., this rather elongate species is distinguished by its strong even punctation on the pronotum and the black rugose portions of the femora.

Distribution (Fig. 76)

Coastal N.T. and Cape York, Qld.

Types

Holotype, male, '12°23'S 132°57'E 5 km NNW of Cahills Crossing, N.T. East Alligator River, vl. 73, Upton & Foehan', in ANIC. Paratypes: six, two same data as holotype, in ANIC; one, 'Mareeba 22.x.1976 K. & E. Carnaby' in CW; one, 'N.T. Junction of Arnhem Hwy & Oenpelli Road M.V. light 26-27 June 1980 M. B. Malipatil', in NTM; one, 'N.T. Lake Bennett area c. 25 km SE of Manton Dam 29-30 Dec. 1979, M. B. Malipatil', in NTM.

Berosus gibbae sp. nov.

(Figs 33, 39)

Description (number examined 17)

Length 4.0–5.0 mm. Elongate oval. Elytra not humpbacked. Shiny but with elytron of many specimens with a fine-meshed reticulation. Apex of elytron with a stout moderately-sized outer spine and a virtually absent inner one. Dorsal surface light-brown, elytral punctures and many striae and vague patches on head, pronotum and elytron darker. Ventral surface dark-brown, appendages lighter, except tip of labial palpi which is dark-brown. Head moderately densely covered with

strong punctures, strong, $2 \times$ size of eye facets except towards front where they become much smaller. Pronotum evenly and quite densely covered with strong punctures, the same size as those at rear of head, a few smaller ones along front and rear margins. Elytral striae moderately impressed, with punctures the same size or slightly smaller than those on pronotum. Second elytron stria with 12 to 18 punctures. Punctures in interstriae smaller than those in striae, larger but shallowly impressed towards side, over most of elytron arranged in one or two irregular lines, often bearing a single seta particularly those towards sides. Punctures in interstria 3 of uniform size. Ventral surface densely but finely rugose-punctate. Midline of mesosternum strongly raised, moderately projecting backwards. Midline of first abdominal segment weakly carinate in front $1/2$ – $1/4$. Metacoxal process raised, triangularly produced backwards, with a broad diamond-shaped area in middle devoid of sculpture. Rugose portion of metafemur $2/3$ – $3/4$ length of femur, that of mesofemur $2/3$, that of profemur about $1/2$ length of femur on rear face.

Male: Protarsi four-segmented, basal segments weakly expanded. Basal segment longer than second, second and third segments subequal in all dimensions. Apical abdominal segment broadly but shallowly notched.

Remarks

This widespread northern species is rare in collections. The peculiar fine sculpture of the elytra, which is either irregular or with a fine grained reticulation, and the presence of a large number of setae-bearing punctures, are reminiscent of *B. nutans* and *B. dallasae* which show these characters to a greater extent. The more normal pattern of elytral punctation readily separates it from these species, in which the elytra are densely and evenly covered with punctures. The round rather than elongate pronotal punctures also separate it from these otherwise quite similar species. The light-coloured rugose portions of the femora separate it from *B. josephinae*.

Distribution (Fig. 78)

Coastal northern Australia.

Types

Holotype, male, 'N.T. Katherine low level Native Park, 25 Ap. 1980 M. B. Malipatil', in NTM. Paratypes; six, two same data as holotype in NTM; four 'N.T. N. P. Korlonjotlok Stream 18 Nov. 1979 M. B. Malipatil', in NTM.

***Berosus majusculus* Blackburn**
(Figs 54, 60)

Berosus majusculus Blackburn, 1888 (1889), p. 824.

Types

Holotype and paratype in BM(NH), seen. Paratype, male, Adelaide, S.A. in SAM, seen.

Description (number examined 336)

Length 6.0–8.7 mm. Elongate oval, elytra not humpbacked. Apex of elytron with two well-developed spines, the outer longer than the inner. Dorsal surface brown with darker mottlings. Elytral punctures and striae black, strongly so on disc, weaker or absent on sides. Ventral surface black. Appendages brown, tip of labial palpi darker. Head relatively narrow, evenly strongly and quite closely punctate, punctures much weaker towards front. Pronotum unevenly covered with moderately dense, well-marked punctures, variable in size, a little stronger laterally with a row of small punctures along front and rear margins. Elytral striae well-impressed, second stria $1/4$ length of elytra. Punctures in striae well-marked, same size or larger than those on pronotum, interstitial punctures not in one line except in some lateral interstriae, well-marked, a little smaller than those in striae, particularly on humeral angles. Reticulation of elytron absent to moderately strong. Ventral surface densely and evenly rugose-punctate. Midline of mesosternum tending to form weak keel, weakly projecting backwards. Midline of first abdominal segment with weak keel in anterior $1/4$. Metacoxal process raised, narrowly triangular. Midline with long narrow area devoid of sculpture. Rugose portion of metafemur $1/2$ to $2/3$ length of femur, that on mesofemur a little over $1/3$ along ventral face, that on profemur about $1/3$ length of femur along ventral face.

Male: Protarsi four-segmented, basal two segments dilated. Basal segment about twice length of subequal second and third segments. Apical abdominal segment notched.

Remarks

This common southern species is readily separated from the rather similar *B. australiae* by lack of black rugose femore. It is more difficult to separate from *B. veronicae*, with which it is generally sympatric, but it is larger and has a greater number of punctures on stria 2. The notch on the last abdominal segment of the male also separates this species from others of its size.

Distribution (Fig. 75)

Southern coastal Australia from Perth to Sydney areas.

***Berosus veronicae* sp. nov.**
(Figs 67, 68)

Description (number examined 209)

Length 3.5–6.4 mm. Elongate oval, elytra not humpbacked. Apex of elytron with two weak blunt spines. Dorsal surface light-brown with darker mottlings. Elytral punctures and striae black, strongly so on disc in many specimens, weakly or not at all laterally. Ventral surface black, appendages light-brown, tip of labial palpi a little darker. Head evenly, strongly and quite closely punctate. Punctures toward front weaker. Pronotum evenly, strongly and quite closely punctate, scattered smaller punctures particularly on disc and front and rear margins, weakly reticulate in some. Elytron variably reticulate from none to moderate. Elytral striae well impressed. Second stria about 1/4 length of elytra. Strial punctures about size of larger punctures on pronotum. Interstriae 1 to 5 scattered, those between more lateral striae tending to be in one row except for extreme lateral edge. Ventral surface densely rugose-punctate. Midline of prosternum weakly and evenly keeled, projecting backwards in weak prosternal process. Midline of first abdominal segment weakly keeled in anterior 1/4. Metacoxal process raised, triangular, midline with diamond-shaped area devoid of sculpture in middle and slight keel to the rear of this area. Rugose portion of metafemur between 1/3 and 1/2 length of femur, that on mesofemur 1/3, that on profemur 1/4 length of femur.

Male: Protarsi four-segmented, basal two segments moderately expanded. First segment about twice length (and size) of second, which is a little longer than the narrow third segment. Apical abdominal segment entire.

Remarks

A common species in southern Australia, this species has frequently been mis-identified in collections, usually as *B. majusculus*. The un-notched apical segment in the male separates it from this species. The smaller size and fewer punctures in the area between the first two elytral striae will separate all but the occasional specimens. *Balbipes* Fauvel is another name that has been attached to specimens of this species but this is a species from New Caledonia with different aedeagus and other characters.

Distribution (Fig. 81)

South-eastern Australia, Tas.

Types

Holotype, male, 'Goulburn', in SAM. Paratypes, 13 same data as the holotype, in SAM; two, 'Albury N.S.W. 1/61 C.W.', in CW.

Berosus australiae Mulsant (Figs 71, 74)

Berosus australiae Mulsant, 1859, p. 58.

Berosus externespinosus Fairmaire, 1879, p. 81, syn. after D'Orehyumont, 1943.

Berosus gravis Blackburn, 1888 (89), p. 826, syn. nov.

Types

Berosus australiae, not located (Hope, Dept of Ent. Oxford, records it as having been sent to BM(NH) in 1925). Type locality 'Australia'.

Berosus gravis: Holotype, male, S.A., in BM(NH), seen. Paratype, male, in SAM, seen. Paratype, male, in SAM, seen. Type locality (Paratype), Murray Bridge, S.A.

Berosus externespinosus, not located (?MHNH). Type locality, Rockhampton, Qld.

Description (number examined 455)

Length 6.5–9.0 mm. Elongate oval, not humpbacked. Apex of elytron with two spines, the outer strong and usually about two times length of inner. Dorsal surface brown to dark-brown with darker mottlings. Elytral striae and punctures outlined in black except for punctures laterally. Ventral surface black. Appendages brown, rugose portion of femora black or dark-brown. Punctures on head moderately strong and dense, much weaker towards front. Pronotum moderately covered with well-marked variable sized punctures, front and rear edges with rows of closely spaced small punctures. Elytron with striae moderately impressed, strial punctures relatively small, about same size as those on pronotum. Interstrial punctures scattered, smaller, those in more lateral interstriae tending to form a single line to varying degrees. Elytron surface shiny or weakly to moderately reticulate with a fine reticulation. Ventral surface densely rugose-punctate. Midline of mesosternum raised into weak keel, weakly projecting backwards. Midline of first abdominal segment weakly keeled in front 1/4. Metacoxal process raised, triangular, with diamond shaped area devoid of sculpture in midline. Rugose portion of metafemur 2/3–3/4 length of femur, that on mesofemur a little more than 1/2, that on profemur about 1/3 length of femur.

Male: Protarsi four-segmented, basal two segments strongly expanded, basal segment about 1.5 × length of second, which is much longer than the small third segment. Apical abdominal segment entire.

Remarks

In southern and eastern Australia this large common species is readily recognized by the black rugose portions of the femora. In northern Australia some specimens have the rugose portions dark-brown and not greatly darker than the rest of the leg, and closely resemble *B. sativae* and *B. decipiens*. Separation of these three species is best

done on aedeagi as, although *B. australiae* is generally larger, and generally has stronger elytral punctures, this is not always so.

Distribution (Fig. 77)

Virtually Australia-wide, more common in south-east than elsewhere, rare in W.A., apparently absent from centre and north of that state.

Berosus decipiens Blackburn

(Figs 47, 52)

Berosus decipiens Blackburn, 1888, p. 827.

Types

Holotype and paratype in BM(NH), seen. Paratype in SAM, seen.

Description (number examined 18)

Length 6.1–8.0 mm. Elongate oval, not humpbacked. Apex of elytron with two weak spines placed close together. Reddish-brown with elytral striae and punctures on elytron and pronotum black, particularly on disc, black areas on elytron coalesced in some specimens to give extensive black areas on disc. Ventral surface black, appendages reddish-brown, rugose portions of femora darker. Head moderately punctate with rather shallow punctures, those in front half smaller. Pronotum sparsely and rather unevenly punctate with small to moderately-sized rather shallow punctures. Front and rear borders with row of shallow small punctures. Elytral striae weakly impressed especially on disc where for most part reduced to a line of punctures. Strial punctures about same size as the large punctures on pronotum. Interstitial punctures sparse and shallow, those on disc smaller (usually much smaller) than those in adjacent striae, weaker laterally. Strong tendency for interstitial punctures to be arranged in one line over most of elytron, in interstriae 3 and 5 there are some scattered larger punctures. Ventral surface rugose-punctate. Midline of mesosternum quite strongly and sharply carinate, weakly projecting backwards. Midline of first abdominal segment without keel. Metacoxal process raised, triangular with rather bowed sides. Midline weakly carinate behind, with narrow area in middle unsculptured. Rugose portion of metafemur 1/2–2/3 length of femur; that of mesofemur about 1/2, that of profemur a little over 1/2 length of femur.

Male: Protarsi four-segmented, basal two segments moderately expanded. First segment about 1.5 × length of second segment which is a little shorter than the narrow third segment.

Remarks

B. decipiens is a northern coastal species resembling *B. australiae*. It differs from that species by generally

being a little smaller and more elongate, and by the weaker and less numerous punctures on elytra and pronotum. The aedeagus and the much larger third segment of the male protarsi separate it from *B. australiae*. I have found no characters that separate this species from *B. sadleae* other than the aedeagus.

Distribution (Fig. 78)

Coastal northern Australia from Wyndham, W.A., to Kuranda, Qld.

Berosus sadleae sp. nov.

(Figs 46, 50)

Description (number examined 2)

Length 4.5–5.0 mm. Narrowly oval. Shiny. Elytron not humpbacked. Apex of elytron with two weak spines, the inner one smaller than the outer. Dorsal surface light-brown, punctures on elytron and pronotum, elytral striae and patches on pronotum and elytron darker. Rear of head dark, centre and front lighter. Ventral surface dark-brown, appendages lighter, rugose portions of meso and meta-femora somewhat darker than rest of legs. Tip of labial palpi dark. Head relatively narrow, relatively sparsely covered with well impressed punctures, about size of eye facet, smaller towards front. Pronotum sparsely covered with punctures, most about 1.5 × puncture width apart, towards midline and in front punctures vary in size. Elytral striae weakly to moderately impressed, strial punctures about size of the larger ones on pronotum. Interstitial punctures smaller. In interstriae 3 and 5 there are some scattered larger punctures. Punctures lateral to about stria 7 weak and arranged in one row, those inward of about stria 7 stronger and tend to be scattered. Stria 2 with 11 to 15 punctures which are about twice as large as those in adjacent interstitial areas. Ventral surface densely punctate. Midline of mesosternum raised, moderately projected backwards. Midline of first abdominal segment weakly raised in front 1/3. Metacoxal process raised, broadly triangularly produced backwards, with small wide diamond shaped portion in middle devoid of sculpture. Rugose portion of metafemur 2/3 length of femur, that of mesofemur 1/2–2/3, that of profemur 1/2 length of femur.

Male: Protarsi four-segmented, basal segment weakly expanded, first segment larger than second which is same length but a little wider than third. Last abdominal segment entire.

Remarks

A northern species known for certain only from the two male types. These are indistinguishable from *B. decipiens* except for the distinctive aedeagus. Both species have been taken together at Howard Springs, N.T., and Lake Bennet, N.T. Further work

is needed to clarify the relationship of this northern group which also includes *B. australiae* and *B. aquilo*. A series of specimens from Lake Bennet, N.T., Dec. 1979, in NTM, includes both *B. sudiae* and *B. decipiens* but most are teneral which precludes extraction of an identifiable aedeagus, hence I cannot be sure to which species various individuals belong.

Distribution (Fig. 79)

Known only from the type localities.

Types

Holotype, male, 'Howard Springs, N.T., at light, 27.1.68, E. Matthews', in ANIC. Paratype, male, 'N.T., Lake Bennett area c. 25 km SE of Manton Dam, 29-30 Dec, 1979, M. B. Malipatil at M.V. light', in NTM

Berosus aquilo sp. nov.
(Figs 34, 40)

Description (number examined 11)

Length 3.3-5.0 mm. Elongate oval. Elytra not humpbacked. Shiny. Apex of elytron with two spines, outer weakly to moderately developed, inner one often lacking. Dorsal surface light-brown, punctures and striae on elytron darker, elytron with one or two darker patches, rear of head darker. Ventral surface dark-brown and black. Appendages lighter, rugose portions of femora dark-brown to black. Head moderately covered with strong punctures about the same size as facets of the eye or slightly larger, much smaller towards front. Pronotal punctures same size as those at rear of head, rather unevenly distributed, all approximately the same size except for a few smaller ones along extreme front margin and on disc. Elytral striae moderately impressed, stronger towards sides and apex. Interstrial punctures smaller than those in striae, arranged in one line over most of elytron, except between striae 1 to 3 and 4 to 5. Area between striae 2 and 3 with a few larger punctures. Second elytral stria with 10 to 16 punctures which are about 3 × size of those in adjacent interstrial areas. Ventral surface densely rugose-punctate. Midline of mesosternum raised, moderately produced backwards. Midline of first abdominal segment carinate in front third. Metacoxal process raised, broadly triangularly produced backwards, midline weakly carinate; a small diamond-shaped area in centre devoid of sculpture. Rugose portion of metafemur 3/4 length of femur, that of mesofemur 2/3, that of profemur 1/2-2/3 length of femur.

Male: Protarsi four-segmented, basal two segments strongly expanded, basal segment larger than second which is about same length as the unexpanded third.

Remarks

A small dark species from coastal N.T. The only small species in this grouping with the rugose portions of the femora darker than the rest of the femur, and usually almost black.

Distribution (Fig. 79)

Known only from the type locality and from Daly River Mission, N.T. (ANIC).

Types

Holotype, male, 'Coastal Plains Research Station, C.S.I.R.O. Darwin, N.T. at light, 30.1.66 E.C.B. Langfield', in ANIC. Paratypes, nine same data as holotype, seven in ANIC, two in CW.

Berosus vijae sp. nov.
(Figs 35, 41)

Description (number examined 31)

Length 3.0-4.5 mm. Narrowly oval, not humpbacked, apex of elytron with two weak broad spines. Yellow-brown, rear of head, areas adjacent to eyes, elytral striae, 2-3 vague patches behind middle of elytron, ventral surface except for appendages darker. Shiny. Head sparsely punctured with variably sized punctures, sparser and weaker towards front and centre. Pronotum sparsely punctured with variably sized but quite well impressed punctures, stronger and denser laterally, front and rear margins with a single row of small punctures irregularly spaced. Elytral striae moderately to quite strongly impressed, particularly towards apex of elytron. Punctures in striae well marked, about same size as the larger ones on pronotum. Interstrial punctures a little to much smaller than those in striae, arranged in single row except in interstrial 2 to 3 which has scattered large and small punctures. Second stria about 1/4 length of elytron with 9 to 13 punctures. Mesosternal keel weakly raised. Metacoxal process triangular with apex towards rear, a small approximately oval area in midline devoid of sculpture. Ventral surface, rugose-punctate with smallish punctures. First abdominal segment with weak midline keel in front 1/4. Rugose portion of metafemur 3/4 length of femur, that of mesofemur 2/3-3/4 that of profemur about 1/2 on front edge and a little greater on hind edge.

Male: Protarsi four-segmented. First three segments subequal in length, first moderately expanded, second rather less so and third not at all. Apical abdominal segment very weakly notched with weak protuberance at each side of notch.

Remarks

A small widespread northern species closely resembling *B. ralphii* and *B. veroniqueae*, separated by range of characters given in Table 2. Generally with

larger elytral punctures and more strongly impressed striae although these are weakly impressed on the disc in some specimens.

Distribution (Fig. 75)

Northern Australia, predominantly the western half.

Types

Holotype, male, 'Tindal, N.T. 14°31'S, 132°22'E. 1-20 Dec. 1967, light trap. W. J. M. Vestjens', in ANIC. Paratypes, four same data as holotype, in ANIC.

Berosus ralphii sp. nov.
(Figs 72, 73)

Description (number examined 18)

Length 3.5-4.5 mm. Oval. Not humpbacked. Apex of elytron truncate or very weakly produced into two broad short spines. Yellow-brown, punctures on elytron and a few small spots in apical 1/2 of elytron darker. Ventral abdominal segments other than apical are blotched darker. Shiny. Elytron often moderately reticulate. Punctures of head moderately impressed, sparse, smaller towards front and center. Punctures of pronotum moderately impressed, sparse, variable in size, with row of small punctures along extreme front and rear margins. Elytron striae moderately to weakly impressed. Punctures on striae close, well impressed, about size of larger pronotal punctures. Interstrial punctures much smaller than those in striae and scattered in interstriae one to five, strong tendency to be arranged in a single row in interstriae lateral to stria 6. Interstria 3 with punctures of two sizes. Stria 2 short, often poorly marked with 7 to 13 punctures. Mesosternal keel moderately raised. Metacoxal process, sharply triangularly produced backwards and downwards, a small slightly raised area in midline in centre. Ventral surface rugose-punctate. First abdominal segment with raised midline keel in front 1/4. Rugose portion of metafemur 3/4 length of femur, that on mesofemur 1/2-2/3, that on profemur 1/4-1/2 length of femur.

Male: Apical abdominal segment sinuate on hind margin. First two segments of protarsi expanded, third segment not expanded. First three segments progressively smaller in length.

Remarks

Similar in general facies to *B. vijae* and *B. veronicae* but differing from them in the greater number and smaller size of the punctures in the first elytral interstriae, where they are arranged in more than one line, and in characters of the aedeagus. In all specimens so far examined the tip of the metacoxal process is sharply deflexed downwards, a character not seen in other Australian *Berosus*.

Distribution (Fig. 77)

Coastal north-western Australia and Queensland.

Types

Holotype, male, 'Wyndham W.A. S. Stephens 20.2.01', in SAM. Paratypes 17; seven same data as holotype, in S.A.M., one 'Derby N.W.A. W. D. Dodd', in SAM; seven 'Derby N.W.A.', in SAM; two 'Queensland J.8261', in SAM.

Berosus subovatus Knisch
(Figs 36, 42)

Berosus sticticus Fairmaire, 1879, p. 82.

Berosus subovatus Knisch, 1924 (not Boheman, 1859)

Type

Holotype, female, Peak Downs N.T., in MNHN, seen.

Description (number examined four)

Length 4.6-5.0 mm. Elongate oval. Elytra not humpbacked. Shiny. Apex of elytron rounded or weakly truncated. Dorsal surface light-brown, punctures and striae on disc of elytron and vague patches on head, pronotum and elytron darker. Punctures in lateral striae on elytron with large squarish darkish subsurface markings. Ventral surface dark-brown to black, appendages lighter, rugose portions of femura with a slightly darker hue than rest of leg. Head with scattered relatively small punctures, those at back of head a little larger than size of eye facet, those towards centre and front of head smaller. Pronotum sparsely and unevenly covered with punctures, of two sizes, larger about same size as those at rear of head. Elytral striae weakly impressed, over most of elytron little more than series of punctures. Second elytral stria with 6 to 7 punctures, about same size or a little smaller than the larger ones on pronotum 2 = size of those in adjacent interstrial areas. Punctures in interstriae 3 and 5 of two sizes. Interstrial punctures lateral to stria 6 arranged in one line. Those towards sides and apex small and weakly impressed. Ventral surface finely rugose punctate. Midline of mesosternum moderately and evenly raised, moderately projected backwards. Midline of first abdominal segment weakly carinate in front 1/4. Metacoxal process raised, triangularly produced backwards, midline carinate in rear 1/4 a large roughly diamond-shaped area in middle, devoid of sculpture. Rugose portion of metafemur 2/3 length of femur, that of metafemur 2/3, that of profemur about 1/2 length of femur.

Male: Protarsi four-segmented, basal two segments moderately expanded. Basal segment larger than second which is larger than third.

Remarks

The relatively small number of punctures in the second elytral stria, strong tendency for punctures in interstriae to be arranged in one line, and sparse and variably-sized pronotal and head punctures separate this species from related species, *B. vijae* and *B. ralphii* are difficult to definitely separate from this species apart from the form of the aedeagus which is considerably shorter than the parameres in *B. subovatus*.

Distribution (Fig. 81)

Known from only two localities: Station Creek in north Qld. (in ANIC), and Katherine, N.T. (in ANIC). (The type is labelled 'Austral').

Berosus nicholasi sp. nov.
(Figs 66, 69)

Description (number examined 51)

Length 5.0–6.5 mm. Elongate oval. Elytra not humpbacked. Apex of elytron weakly extended with two small spines, inner one often small or lacking. Shiny, often moderately reticulate with a very fine even reticulation. Dorsal surface light-brown with punctures, elytral striae and patches on head, pronotum and elytron dark-brown. Ventral surface dark-brown to black with lighter mottlings. Appendages brown, tip of labial palpi darker. Head relatively narrow, evenly and quite densely covered with strong punctures, punctures weaker towards front. Pronotum moderately but unevenly covered with strongly impressed punctures of two general sizes with the larger ones predominating, rows of small punctures along front and rear margins. Elytral striae quite strongly impressed except towards sides and back. Strial punctures relatively small, a little smaller than the larger ones on the pronotum. Interstitial punctures small, relatively sparse, those lateral to stria 8 arranged in one line, smaller than strial punctures over most of elytron. Some of the more central interstriae with a few large punctures with short setae. Ventral surface densely rugose-punctate. Midline of mesosternum raised, moderately projecting backwards. Midline of first abdominal segment carinate only in extreme front. Metacoxal process raised, triangularly produced backwards, small elongate oval area in centre devoid of sculpture. Rugose portion of metafemur 2/3–1/4 length of metafemur, that of mesofemur 1/2–2/3, that of profemur 1/3–1/2 length of femur.

Male: Protarsi four-segmented. Basal segments subequal, quite strongly dilated. Apical abdominal segment not notched.

Remarks

One of a group of very similar northern species which can only be confidently separated by

characters of the aedeagus. In all but a few cases, larger than other species in the group other than *B. dehillipennis*, which usually has much stronger punctures on the elytron. See Table 2.

Distribution (Fig. 79)

Coastal northern Australia from Derby, W.A. to Townsville, Qld.

Types

Holotype, male 12°28'S 131°03'E Howard Springs, N.T. 24 km S of Darwin 10.xi.72, rainforest, at light, E. Britton, in ANIC. Paratypes, 12 same data as holotype; 11 in ANIC, one in CW.

Berosus dehillipennis Blackburn
(Figs 44, 45, 49, 51)

Berosus dehillipennis Blackburn, 1898, p. 223.

Type

Holotype, female, Cape York, Qld. in BM(NH), seen.

Description (number examined 74)

Length 4.0–6.0 mm. Elongate oval. Elytra not humpbacked. Apex of elytron rounded or with two weak spines. Dorsal surface light-brown with punctures on pronotum and elytron, elytral striae and patches on pronotum and elytron darker. Rear of head dark-brown, centre and front lighter. Ventral surface dark-brown, appendages lighter, tip of labial palpi dark-brown. Head with sparse to moderately dense, strong punctures, a little larger than eye facets, grading to obsolete towards front. Pronotum rather unevenly but moderately covered with strong punctures the size of those at rear of head, a few smaller punctures towards midline and front. Elytral striae quite strongly impressed particularly laterally and towards rear. Second elytral striae with 10 to 18 punctures, 2x the size of those in adjacent interstitial areas. Interstitial punctures scattered not arranged in a single row except in some places towards sides and rear. A few large punctures in interstriae 3 and 5. Ventral surface densely rugose-punctate. Midline of mesosternum weakly raised, moderately projected backwards. Midline of first abdominal segment weakly carinate at extreme front. Metacoxal process raised, narrowly triangularly produced backwards, with a narrow diamond-shaped area in middle unsculptured. Rugose portion of metafemur 2/3–3/4 length of femur, that of mesofemur 1/2–2/3, that of profemur 1/3–1/2 length of femur.

Male: Protarsi four-segmented. First and second segments moderately expanded, first much longer than second, which is about the same length as third. Apical abdominal segment broadly but very weakly notched.

Remarks

A widespread northern species which I initially considered to be composed of at least two species. Further study may show that it includes several closely related species. In particular, individuals can be placed in one of two groups according to the shape of the aedeagus. One group has the parameres thin and the aedeagus roundly hooded at the tip, the other has thick parameres and has a transverse ridge on the upper surface behind the roughened end portion of the aedeagus. These characters are

to some extent variable and intermediates exist, e.g. notably a specimen from Cunnamulla, Qld., in SAM. This species can be separated from the rather similar *B. nicholasi* by the usually much stronger elytral punctures and the relatively smaller second segment of the male protarsi (Table 2).

Distribution (Fig. 80)

Coastal northern Australia from Derby to Cairns region.

CHECKLIST OF AUSTRALIAN *BEROSUS*
(in alphabetical order)

B. australiae Mulsant
= *externespinosus* Fairmaire
= *gravis* Blackburn
B. amoenus sp. nov.
B. arcus sp. nov.
B. approximans Fairmaire
= *B. auriceps* Blackburn
= *B. blackburni* Zaitz
= *B. ovipennis* Fairmaire
= *B. simulans* Blackburn
= *B. stigmaticollis* Fairmaire
B. aquilo sp. nov.
B. dallasae sp. nov.
B. debilipennis Blackburn
B. decipiens Blackburn
B. discolor Blackburn
= *B. flindersi* Blackburn
B. duplopunctatus Blackburn
B. gibbae sp. nov.
B. involutus (W. MacLeay)
B. josephenae sp. nov.
B. juxtadiscolor sp. nov.

B. macropunctatus sp. nov.
B. macumbensis Blackburn
B. majusculus Blackburn
B. munitipennis Blackburn
B. nicholasi sp. nov.
B. niger sp. nov.
B. nutans (W. MacLeay)
= *B. pallidulus* Fairmaire
B. pulchellus W. MacLeay
= *B. devisi* Blackburn
B. queenslandicus Blackburn
= *B. quartinus* d'Orchymont
B. quadrapunctatus sp. nov.
B. ralphi sp. nov.
B. reardonii sp. nov.
B. sadieae sp. nov.
B. subovatus Knisch
= *B. sticticus* Fairmaire
B. trishae sp. nov.
B. timmsi sp. nov.
B. veronicae sp. nov.
B. vijae sp. nov.

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NABIDAE (HETEROPTERA) OF VANUATU

BY I. M. KERZHNER

Summary

Six species are listed, one of them (*Stenonbis nitidicollis* Kerzh.) is new from the Vanuatu fauna. Keys to adult Nabidae and to fifth instar larvae of *Arbela* occurring in Vanuatu are given.

NABIDAE (HETEROPTERA) OF VANUATU

I. M. KERZHNER

KERZHNER, I. M. 1987. Nabidae (Heteroptera) of Vanuatu. *Rec. S. Aust. Mus.* 21(1): 29-33.

Six species are listed, one of them (*Stenonabis nitidicollis* Kerzh.) is new from the Vanuatu fauna. Keys to adult Nabidae and to fifth instar larvae of *Arbela* occurring in Vanuatu are given.

I. M. Kerzhner, Zoological Institute, Academy of Sciences of the U.S.S.R., Leningrad 199034, U.S.S.R. Manuscript received 17 February 1986.

Previous records of Nabidae from Vanuatu (formerly the New Hebrides) were based on the material in the Museum National d'Histoire Naturelle, Paris (Reuter 1908); the British Museum (Natural History), London (Harris 1938, 1939; Kerzhner 1970a); and the Universitetets Zoologiske Museum, Copenhagen (Kerzhner 1970b). In all, five species have been recorded.

The material received from the South Australian Museum, the B. P. Bishop Museum and the U.S. National Museum of Natural History (thanks to the kindness of Dr G. F. Gross, the late Dr J. L. Gressitt and Dr Th. J. Henry) contains all of the species already known from Vanuatu and one species new for the fauna.

In the distribution lists below, only localities and collecting dates are mentioned. The data on expeditions, collectors and deposition of material for corresponding years are as follows:

1943 — collector Knight; deposited in the U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA;

1950 and 1970 — collector N. L. H. Krauss; deposited in the B. P. Bishop Museum, Honolulu, Hawaii, USA;

1957 — collector J. L. Gressitt; the same museum;

1958 — collector Borys Malkin; the same museum;

1960 — collector W. W. Brandt; the same museum;

1964 — collector R. Straatman; the same museum;

1965 — Biospeleological Expedition, collector G. F. Gross; deposited in the South Australian Museum, Adelaide, South Australia;

1967 — collectors J. & M. Sedláček; deposited in the B. P. Bishop Museum;

1971 — Royal Society and Percy Sladen Expedition; collectors — P. Cocherneau (on Malekula I.), G. F. Gross (on all other islands), Masing Andrew (who assisted G. F. Gross on Tanna I.); deposited in the South Australian Museum, but duplicates from large series will be

sent to British Museum (Natural History), Museum National d'Histoire Naturelle, Paris, or will be retained in Zoological Institute, Leningrad;

1973 and 1976 — collector N. L. H. Krauss; deposited in the U.S. National Museum of Natural History.

SYSTEMATICS

Gorpis similimus Harris (Figs 1-3)

Previous records

MALEKULA. Harris 1939: 150-151.

Material examined

ESPIRITU SANTO: Apouna R. Camp 2, 146 m, 30.VIII.1971; at light, 1 ♀; above Namatasopa, 400 m, 30.VIII.1957, 1 ♀; Hill E. of Luganville, 100 m, Macaranga, 10.IX.1957, 1 ♂.

General distribution

Vanuatu (type locality) and Solomon Islands.

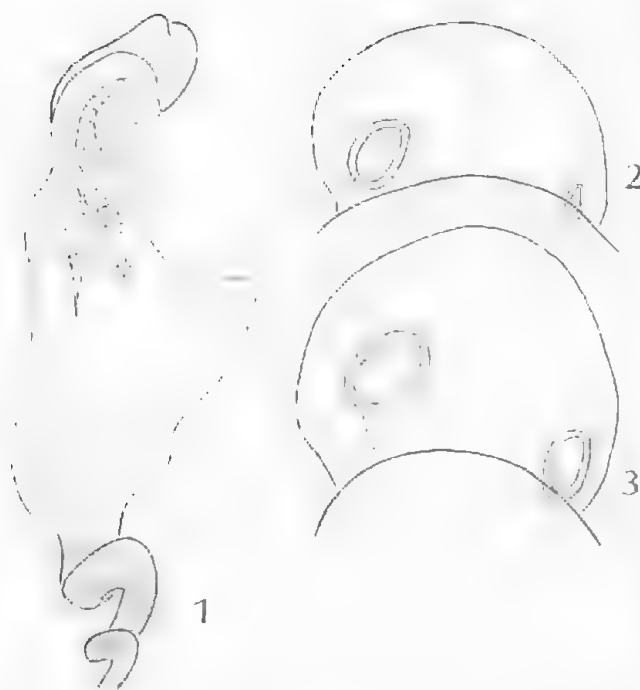
Remarks

Previously (Kerzhner 1970a) I mentioned that there were some colour differences between specimens from Vanuatu and the Solomon Islands. These differences are in the main confirmed by the new material. In addition, slight differences in male and female genitalia (Figs 1-3) have been found. However the material at hand is insufficient for a study of individual variability and therefore I refrain from description of a new subspecies for the Solomon Islands population.

Arbela immista Harris

Previous records

MALEKULA. Harris 1938: 579; Kerzhner 1970a: 298; 1970b: 192.



FIGURES 1-3, *Gorpis simillimus* Harris. 1, male from Vanuatu (Espiritu Santo), acedeagus; 2, female from Vanuatu (Espiritu Santo), vagina in ventral aspect; 3, female from Solomon Islands (Guadalcanal), the same.

Material examined

ESPIRITU SANTO: Baldwin Bay, 17.VIII. 1958, 1 ♀; 25 km NE Luganville, 12.IV.1964, 1 ♂, 1 ♀. PENTECOST (NE): 200-500 m, 27.III.1964, 1 ♂. MALEKULA: Amok, 17.IX.1958, 1 ♂; South West Bay, 11 and 13.X.1971, by beating trees and sweeping grasses in the forest and along the river of the forest, 9 ♂, 10 ♀, 4 larvae.

General distribution

Vanuatu (type locality) and the Bismarek Archipelago.

Arbela costalis Stål

Previous records

BANKS, MALEKULA, ERROMANGA. Harris 1938: 581; Kerzhner 1970a: 298.

Material examined

API ('Epi'): Vaemali, 10.VIII.1967, 1 ♂. ERROMANGA: Ipota, 0-100 m, March 1970, 2 ♂; Ipota, vicinity of Ipota, and River Camp between Ipota and Nuankao, 4, 5, 7, 12.VIII.1971, 4 ♂, 3 ♀. TANNA: Lenakel, 0-150 m, March 1970, 1 ♀; between Lenakel and Bethel, 28.VII.1971, 1 larva. ANEITYUM: vicinity of Analgahaut, 19.VII.1971, 1 ♂, 1 larva.

General distribution

Fiji (type locality), Samoa, Vanuatu and Solomon Islands.

Arbela nitidula (Stål)

Previous records

MALEKULA. Reuter 1908: 127; Harris 1938: 568.

Material examined

ESPIRITU SANTO: Second Channel, Santo, Aug. 1950, 2 ♀; Naniatasopa, 300 m, 28.VIII.1957, 1 ♀; below Namatasopa, 250 m, 2 and 3.IX.1957, 1 ♂, 1 ♀; Tasmalum, 3 m, bush, 4.IX.1957, 1 ♂; Luganville, 23-28.VII.1958, 1 ♂; Baldwin Bay, 28-30.IX.1958, 1 ♀; Narango, 90 m, May-June 1960, 2 ♀; Apouna R. Camp 2, 146.3 m, 2, 3.IX.1971, 10 ♂, 7 ♀, 3 larvae; Malao Village, Big Bay Area, 23.VIII.1971, 1 larva. MALEKULA: Amok, 17.IX.1958, 3 ♂, 4 ♀, 1 larva; South West Bay, 13-14.X.1971, beating small trees and sweeping grasses along the river to the forest and on swamp, 4 ♂, 2 ♀. EFATE: Maat (Mat, Ambryn Vill.), 3 m, 15.VIII.1957, 1 ♀; Limestone, Plateau N of Maat, 100 m, 18, 20.VIII.1957, 2 ♂; Vila, 0-100 m, Jan. 1976, 1 ♀. ERROMANGA: Ipota, 5.VIII.1971, 3 ♀. TANNA: between Lenakel and Balhel, 28.VII.1971, 1 ♂, 2 ♀. ANEITYUM: vicinity of Analgahaut, 18-20.VII.1971, 3 ♀.

General distribution

From India and south China to Vanuatu.

Stenonabis nitidicollis Kerzhner (Figs 4-6)

Material examined

ESPIRITU SANTO: Nokowoula, 1100 m, 14.IX.1971, by sweeping, 1 brachypterous female.

General distribution

Australia, Vanuatu (new record).

Remarks

S. nitidicollis was described (Kerzhner 1970a) from a macropterous female, collected in New South Wales, Mrs N. Strommer (formerly N. Winkler), now in Heathmount, Melbourne, kindly informed me that she has examined macropterous and brachypterous males and females of *S. nitidicollis* from Queensland. I compared the

female (Fig. 4) from Vanuatu with the holotype of *S. nitidicollis*.

The vagina in the Vanuatu female (Figs 5, 6) is slightly larger (width 1.00 mm, in the holotype 0.93 mm), the dark coloration of the body is more pronounced and the hind lobe of pronotum has an intermediate longitudinal brownish stripe on each side between the medial and lateral stripes, the antennae are longer (length of the first segment 0.93 mm, of the second 1.33 mm), and also the legs and rostrum are slightly longer. All these differences do not surpass the level of individual and geographic variability in related species.

In the Vanuatu specimen, head width 0.76 mm, vertex width 0.34 mm, hind lobe of pronotum length 0.43 mm, width 1.29 mm, scutellum of equal

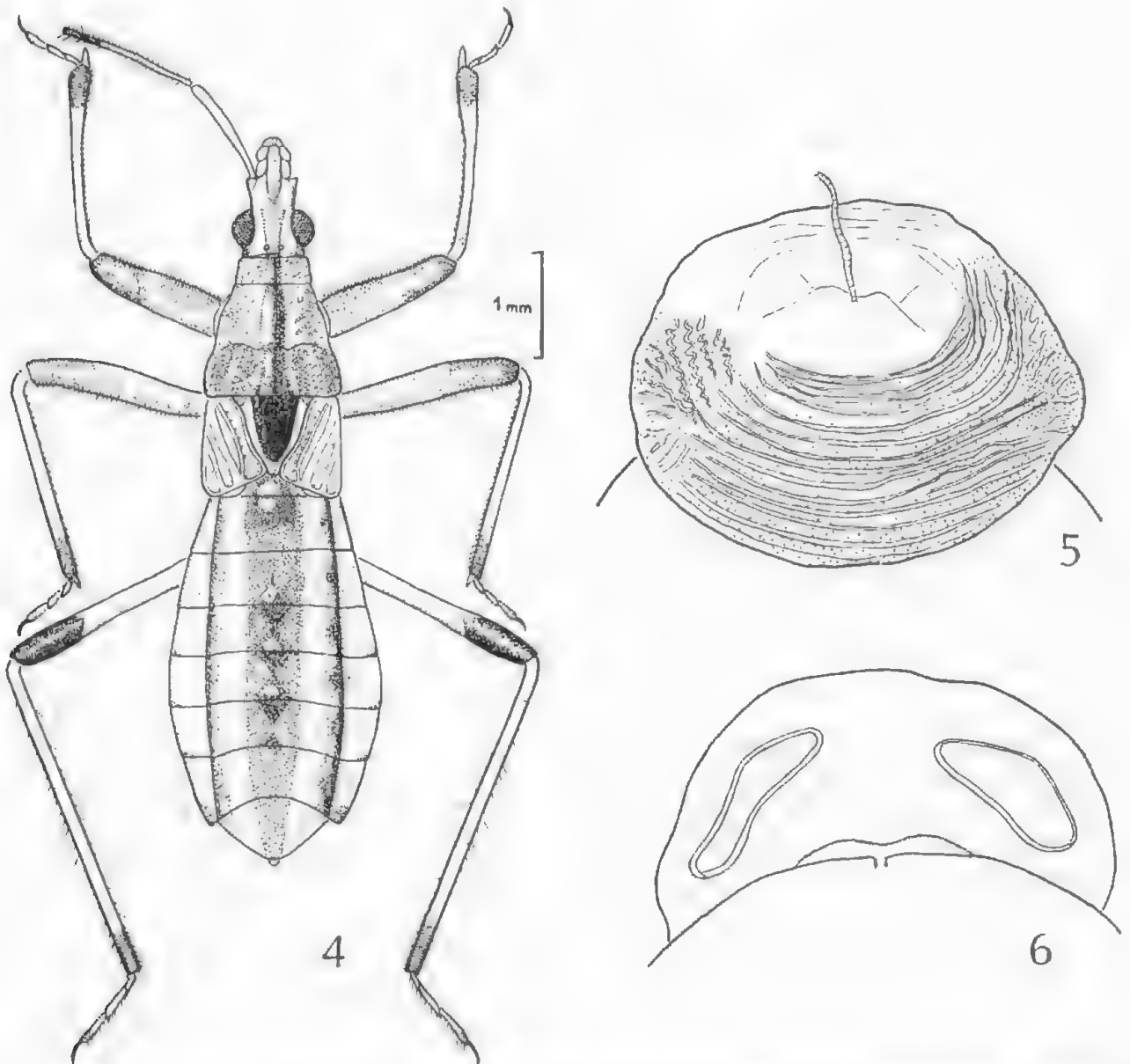
length and width, body length 6.7 mm, width of abdomen 2.0 mm.

Nabis (Tropiconabis) kinbergii Reuter, 1872

Nabis nigrolineatus (Distant, 1920). *Nabis tasmanicus* Remane, 1964. *Nabis capsiformis* auctt. (non Germar, 1838), part.

Previous records

'NEW HEBRIDES' (as *Reduviolus capsiformis*). Reuter 1908: 114. TANNA (as *Nabis nigrolineatus*). Kerzhner 1970a: 355.



FIGURES 4-6. *Stenonabis nitidicollis* Kerzhner, brachypterous female from Vanuatu. 4, dorsal aspect; 5, vagina in dorsal aspect; 6, vagina in ventral aspect.

Material examined

ESPIRITU SANTO: no exact locality, Oct. 1943, 1 ♀; Second Channel, Santo, Aug. 1950, 1 ♀; Luganville, 20, 23-28.VII.1958, 17 ♂, 2 ♀, 1 larva; 10 km W. Luganville, 10.III.1964, 1 ♀; Santo, 13, 14.XII.1965, 1 ♂, 1 ♀; Malao Village in Big Bay Area, 28.VIII.1971, 1 ♀, MALEKULA: Amok, 17.IX.1958, 1 ♀, 1 larva; Lakatoro, 16-17.X.1971, 1 ♂. EFATE: Vila, Aug. 1950, 1 ♀; Vila, 0-100 m, Feb. and March 1970, 1 ♂, 1 ♀; Vila, 0-200 m, Feb. 1973, 1 ♀; Vila, 0-100 m, Jan. 1976, 2 ♂; SE corner, 10.VII.1971, 1 ♂, 1 ♀; Plantation Gaillarde nr. Tagobe, 11.VII.1971, 1 ♀. ERROMANGA: 11 km W. of Ipota, 100-200 m, Feb. 1970, 1 ♂; Ipota, 0-100 m, March 1970, 1 ♂; Ipota and vicinity of Ipota, 5, 6, 10, 12.VIII.1971, 5 ♂, 9 ♀. TANNA: East Coast, 450 m, 8.III.1964, 1 ♂, 1 ♀. Some specimens are taken at light.

General distribution

Australia and Pacific islands. The most remote records are Ryukyu and Bonin Islands, New Guinea, Samoa, Society Islands and New Zealand.

Remarks

The species was known formerly as *N. tasmanicus* and then as *N. nigrolineatus*. However some doubts existed on the last name because W. L. Distant described the species in Reduviidae (genus *Sastrupoda*) and mentioned a number of characters not appropriate to Nabidae. I examined the type series of *N. kinbergii* (Naturhistoriska Riksmuseet, Stockholm), which included 1 female from Sydney, belonging to *N. nigrolineatus*, and 2 females from Buenos-Aires, belonging to *N. cupsiformis*. I designated the specimen from Sydney as the lectotype of *N. kinbergii* and this name should be used for the species occurring in Australia and surrounding islands (Kerzhner 1981; Woodward & Strommer 1982).

KEY TO ADULT NABIDAE OCCURRING IN VANUATU

Note. The key is intended only for determination of Vanuatu material, therefore some of the characters mentioned are not applicable to all species of included genera nor to all populations of the included species.

1. Fore coxal cavities closed behind. Fore coxae slender, greatly elongated, Fore tibiae curved, shorter than fore

femora *Gorpis* Stål

One species — *G. similimus* Harris

- Fore coxal cavities open behind. Fore coxae nearly conical, less than twice as long as thick. Fore tibiae straight, subequal in length to the fore femora ...

..... 2

2. Fore and middle femora and tibiae with long slender spines. Ocelli contiguous *Arhela* Stål (see 3)

- Femora and tibiae without long spines. Ocelli well separated ...

..... 5

3. Pronotum dirty yellow with two longitudinal brown or black stripes, seldom completely light coloured. Hind lobe of pronotum not dull, but not so strongly shining as the fore lobe. Hind tibiae of the male with a densely pilose sub-basal thickening *A. nitidula* (Stål)

- Pronotum (except in distinctly teneral specimens) completely black or with only corners or sides of the hind lobe yellow. Hind lobe of pronotum either velvety dull, or as strongly shining as the fore lobe. Hind tibiae of the male without thickening ...

..... 4

4. Hind lobe of pronotum dull ...

..... *A. immista* Harris

- Hind lobe of pronotum strongly shining ...

..... *A. costalis* Stål

5. Hind lobe of pronotum punctured. Connexivum below not separated from the venter by a suture. Short- or long-winged ...

..... *Stenonabis* Reuter

One species — *S. nitidicollis* Kerzhner

- Hind lobe of pronotum without punctures. Connexivum below separated from the venter by a suture lying in a deep impression. Long-winged ...

..... *Nabis* Latreille

One species — *N. kinbergii* Reuter

KEY TO FIFTH INSTAR LARVAE OF *ARBELA* OCCURRING IN VANUATU

1. Wing pads black with the apical third white ...

..... *A. immista* Harris

- Wing pads unicolorous ...

..... 2

2. Wing pads black ...

..... *A. costalis* Stål

- Wing pads light coloured ...

..... *A. nitidula* (Stål)

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INTRODUCTORY STUDY OF ADVANCED ORIBATE MITES (ACARIDA) : CRYPTOSTIGMATA : PLANOFISSURAE) AND A REDECSCRIPTION OF THE ONLY VALID SPECIES OF CONSTRICTOBATES (ORIPODOIDEA)

BY D. C. LEE

Summary

The study of advanced oribate mites (Planofissurae, new name) is introduced as a further part of an ongoing study of sarcoptiform mites from South Australian surface soils. Morphology is considered with reference to a unified notation for hysteronotal chaetotaxy, notal pores, the form of leg trochanters, acetabula and apodemes. Constrictobates lineolatus Balogh and Mahunka is redescribed from South Australian material, the generic diagnosis is modified, Constrictobatinae (Fenicheliidae) is newly synonymised with Pseudoppiinae (Oribatulidae), and the superfamily Oripodoidea is considered.

INTRODUCTORY STUDY OF ADVANCED ORIBATE MITES (ACARIDA: CRYPTOSTIGMATA:
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CONRICTOBATES (ORIPODOIDEA)

D. C. LEE

LEE, D. C. 1987. Introductory study of advanced oribate mites (Acarida: Cryptostigmata: Planofissurae) and a redescription of the only valid species of *Constrictobates* (Oripodoidea). *Rec. S. Aust. Mus.* 21(1): 35-42.

The study of advanced oribate mites (Planofissurae, new name) is introduced as a further part of an ongoing study of sarcoptiform mites from South Australian surface soils. Morphology is considered with reference to a unified notation for hysteronotal chaetotaxy, notal pores, the form of leg trochanters, acetabula and apodemes. *Constrictobates lineolatus* Balogh and Mahunka is redescribed from South Australian material, the generic diagnosis is modified, Constrictobatinae (Lenicetidae) is newly synonymised with Pseudoppiinae (Oribatulidae), and the superfamily Oripodoidea is considered.

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This is a further part of an ongoing study of sarcoptiform mites from surface soil sampled from nine florally diverse South Australian sites. The primitive oribate mites have been considered elsewhere (Lee 1981, 1982, 1985), and here the study of advanced oribate mites is introduced. The majority of the oribate mites sampled belong to this group which, because of morphological changes, requires a consideration of homology and notation. Furthermore, because a new diagnostic character state for these mites is recognised, and the opinion that they should be unnamed (Lee 1985) is revoked, they are rediagnosed and dealt with under a new name (Planofissurae).

The description of the primitive oribate mites in this study has been thorough but time-consuming. Balogh & Mahunka (1983) suggest that 'painstaking scrutiny, using some recently discovered features' is not worth doing for only some members of a genus. Whilst appreciating this point, the paucity of a common denominator description is so limiting for many oribate mite groups that a more substantial level had to be undertaken, but not to such an extent as in my previous work. The dorsal and ventral aspects of the soma and the shape of the leg segments have been described, but not the gnathosternum or the chaetotaxy and form of the hairs on the legs.

The first superfamily to be considered is the Oripodoidea, partly because it is a diverse and dominant group within the well-established Poronotae, and partly because it is not only important in the study of soil zoology, but some of its members are intermediate hosts of anoplocephalid tapeworms, being infected by the cysterceroid (bladder worm) stage. The most recent work on the

Oripodoidea is by Balogh & Balogh (1984), referring to it as the 'Oribatuloidea' as well as excluding the Mochlozetidae and Parakalummidae. It includes 20 families in the superfamily, of which half are listed as new. The work gives great importance to whether or not the hysteronotal foramina are multiporose, sacculate or a mixture of both those character states. The keys and diagnoses use few character states, which for Constrictobatinae (the only family group so far considered) are in part inaccurate. Despite this, the work is valuable on the basis for studying oripodoids.

Constrictobates was selected as an example, because it is unique within the Oribatuloidea in having 15 pairs of hysteronotal setae on the adult. This is only one pair less than in the holotrichous state amongst primitive oribate mites and is therefore valuable in homologizing the hysteronotal chaetotaxy of the two groups.

The South Australian mites examined are deposited in the South Australian Museum; the types have been returned to the Hungarian National Museum.

MORPHOLOGY

Hysteronotal chaetotaxy

There are three regularly used notational systems for the hysteronotal chaetotaxy, depending on whether they have a full complement of either 16, 15 or 10 pairs of setae. The multiplicity of systems is based on uncertainties of homology. I introduced another system (Lee 1981) for the primitive oribate mites (16-pairs chaetotaxy) with the intention of applying it to all sarcoptiform mites. The chaetotaxy

of oripodoid mites, for which both the 15-pairs and 10-pairs chaetotaxies have been used, is homologized here with the 16-pairs system as illustrated (Figs 1, 2). Because most advanced oribatid mites have 15 pairs of hysteronotal setae on the tritonymph, both systems have sometimes been used for one species. Certainly, with the substantial change in form between the nymphal and adult stages, any proposals of homology are uncertain. On the other hand, I consider that the heuristic advantage of a uniform notation outweighs the disadvantage of using an uncertain homology.

Previously (Grandjean 1954, Lee 1984) it has been stated that all Planolissuræ (=Circumdehiscenciae) lack seta *J4* (= *J1*). The loss of *J4* (and often *J2* and *J3*) occurs in the most primitive subsection of the Planolissuræ, the Pherenotac, with the exception of the Hermaniellidae where such setae are very small under the hysteronotal scalp, but there is a derived reversal of this loss and the seta that is absent from the 15-pair system of the oripodoid mites is *S2*.

The possible loss of setae in handling specimens, when only a few are available, can make it uncertain as to whether a setal base locates a vestigial or a broken off seta. In either case, it will be regarded as present in the chaetotaxy.

Notal pores

The slit-like pores (*h/1*–*h/6*) and the pore leading to the hysteronotal gland duct (*hG/*) are treated as before, but the notation and signatures for the areolar pores, sacculi and reduced sacculi are changed. There is little doubt that these three structures

(sometimes referred to as uctotaxic organs because four pairs are often conspicuous on the hysteronotum) are homologous, but their function is uncertain. They are often regarded as respiratory (Wallwork 1969), but they may be either respiratory or glandular (Hammen 1980). Here they are referred to as *foramina* (singular: *foramen*), and as either multiporose, sacculate, or uniporose. The term 'foramen' has been used for a thin patch bearing the infracapitular gland orifice on the gnathosternum (Hammen 1983), but this is considered as the unnecessary commitment of a valuable term to a trivial structure. The commonest state of the foramina is multiporose, which is regarded as primitive. The hysteronotal foramina may be sacculate or uniporose, which are regarded as derived. Their signature is 'F' and the foramina are numbered depending on position: lateral proteronotal (*F1*), dorsosejugal (*F2d*), laterosejugal (*F2l*), the four hysteronotal pairs (*F3*, *F4*, *F5*, *F6*), a postanal strip (*F7*). A particular hysteronotal foramen may be divided into two parts, which are then given the signature suffix of either 'a' or 'b'.

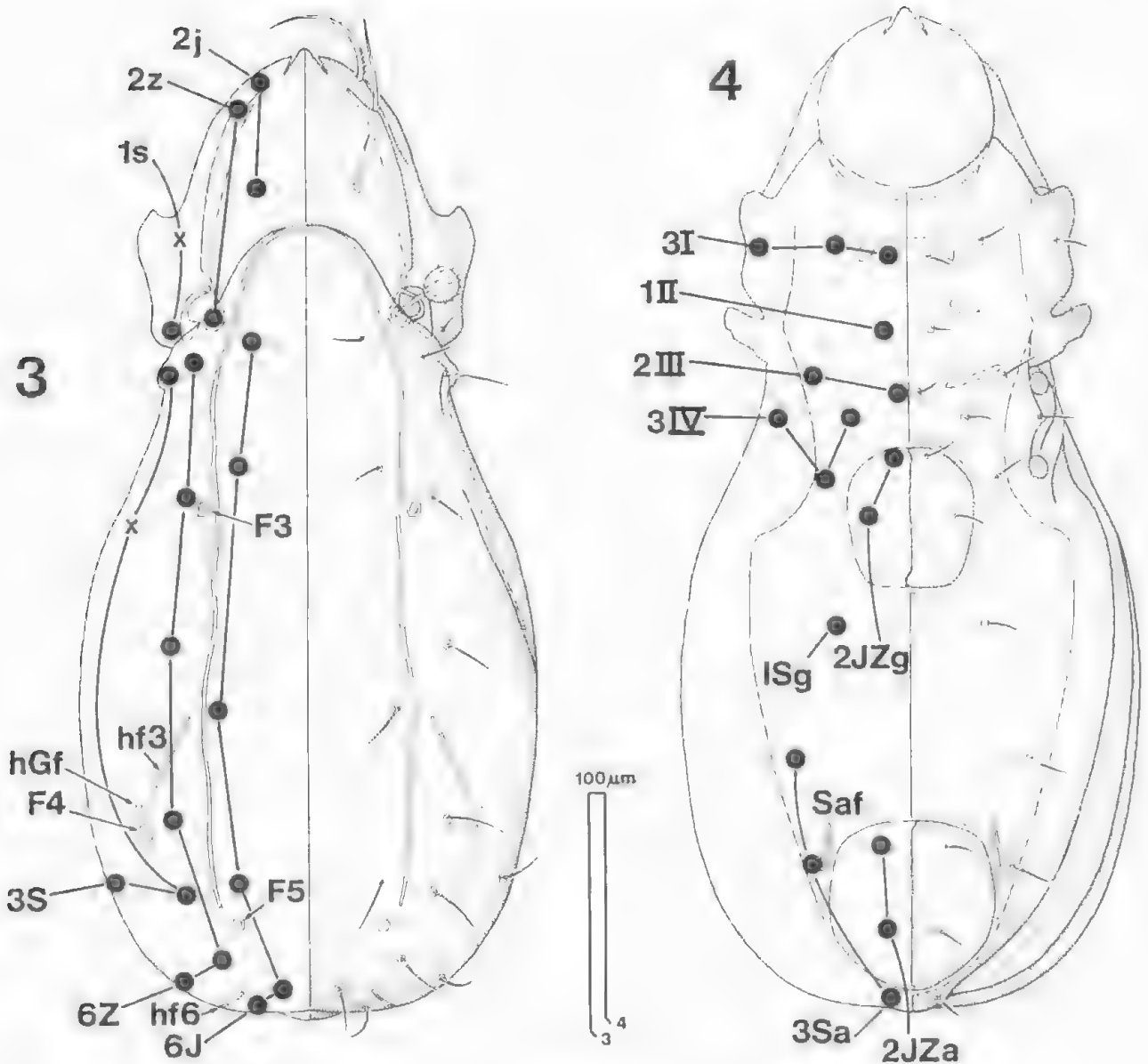
Form of leg segments (particularly the trochanter) and the acetabular cavity

Mite leg segments are primitively subcylindrical, with some tapering, and with only moderate variation in segment size. This is the case in primitive oribatid mite groups except that the coxa is merged into the podosoma. Diversification in shape and size has been derived in at least two suborders (Profissurida, Comalida). It is difficult to rigidly categorize the various shapes, but the derived segment shape is termed *pedunculate*. The pedunculate segment has a caput, stalk and pedestal. The proximal stalk varies in relative size, as to whether it is gradually or abruptly delineated from the caput and as to whether its axis is continuous with or at an angle to that of the caput. The pedestal may be an inconspicuous flared out base to the stalk or it may be larger than the stalk and caput combined (Fig. 6 — note trochantera I and II, state found in all Planolissuræ).

The acetabulum is a socket in the coxite (merged coxa with podosoma). In most primitive oribatid mites the socket edge is level with the rest of the prosomatic exoskeleton, but there may be a derived state where the raised edge partly encloses the trochanter (e.g. *Phyllhermannia eisetosa* Lee, 1985: Fig. 5). In contrast, the trochanteral pedestal of the Planolissuræ is totally encompassed within an *acetabular cavity* (not illustrated since it is internal), which has a proximal *acetabulum* and an external aperture, termed the *acetabular access*. In the case of legs I and II, the trochanter is represented mainly by its pedestal, and is nearly absent externally. Apodemes extend from the proximal walls of

1			2				
S	Z	J	S	Z	J		
1	c3	c2	c1	X	1a	X	1
2	X	1a	da	X	1c	X	2
3		1m	dm		X	1i	3
4		1p	dp		1s	X	4
5	h3	h2	h1	r3	12	11	5
6	ps3	ps2	ps1	n3	p2	p1	6

FIGURES 1 AND 2. Equivalent notations for hysteronotal chaetotaxy used in this study (signatures at periphery with capital letters for files and numbers for ranks). 1, 15-pairs system (c2 etc.); 2, 10-pairs system (1a etc.). X = seta absent, would be present in full complement of 16 setal pairs.



FIGURES 3 AND 4. *Constrictobates lineolatus*, female soma. 3, notum; 4, idiosternum.

acetabular cavities to bases on the prosternal integument. The full complement of *prosternal apodeme bases* is five pairs (I, II, sejugal, III, IV). There is also a pleural apodeme associated with the sejugal furrow, which merges dorsally with the bothridium to seta $z1$, termed the *bothridial apodeme*.

The trochanter is illustrated in this paper (Fig. 6) in order to demonstrate a synapomorphy of the Planofissurae, but when it is similar to this in later works it may not be figured. Although hairs of the legs are not normally considered, they may be illustrated in some cases in relation to segment shape as with the long, flagelliform solenidia on tubercles or a ventral setae near a flange a femur II.

Measurements

Measurements are in microns (μm) and applied as before (Lee 1981: 201), except that gnathosternal

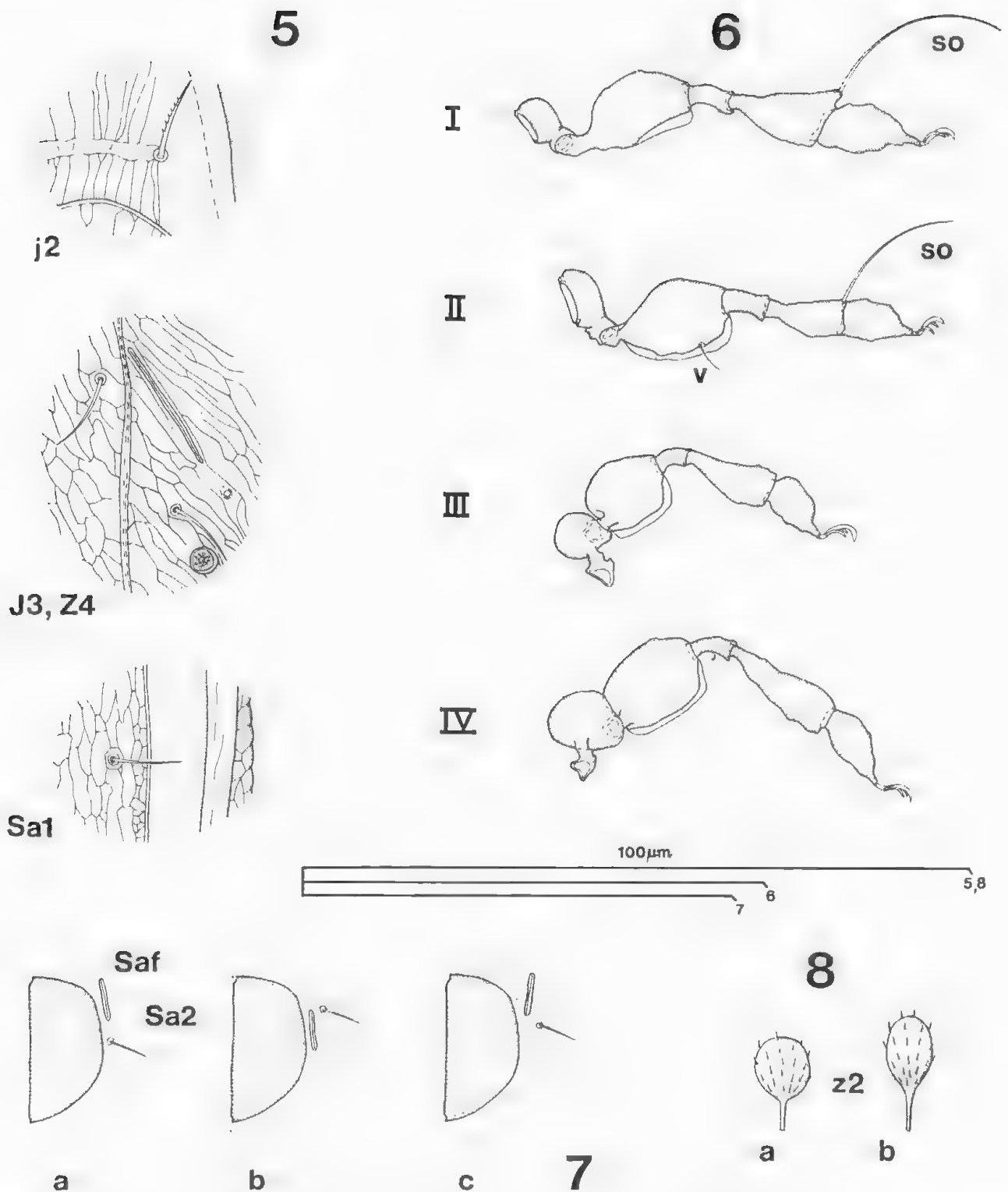
appendages are not considered. Also, because the trochantera are either obscured in the soma or have an angled stalk, they are excluded from the leg measurements. The length for a leg is the total of the lengths of each of the distal four segments (femur, genu, tibia, tarsus) disregarding the pretarsus, and the breadths are the greatest width (usually the height) of the tibia.

SYSTEMATICS

Section PLANOFISSURAE new name

Diagnosis (Adults)

Comalida. Holosomatina. Gnathosternum with dicoxal fissure usually present. Leg trochantera pedunculate with pedestal (on legs I and II comprising most of segment) encompassed within acetabular cavity. Tracheae usually opening into



FIGURES 5-8. *Constrictobates lineolatus*, female. 5, integumental striations and structures around setae *j2*, *J3/Z4*, *Sa1*; 6, right legs I-IV, femora/tarsi — posterior aspect, trochantera — dorsal aspect; 7, various positions of pore and seta beside left anal shield; 8, proteronotal sensory seta (*z2*) with capitate (a) and clavate (b) forms.

some acetabular cavities. Leg genu usually less than quarter volume of tibia. Hysterosomal dehiscence line circumnotal.

Remarks

The Planofissurae is a well established taxon also known as the Circumdehiscenciae (Grandjean, 1954)

or the Euoribatida (Balogh & Mahunka, 1979). I have previously considered it as an unnamed taxon (Lee 1985: 50), preferring to use the slightly more extensive Holosomatina (= Brachypylini: Balogh 1972), regarding the fusion together of the coxites into a single shield in the latter taxon as a more important evolutionary event. Also, the Plano-

fissurae has been difficult to diagnose because the form of the hysteronotal dehiscence line is obscure (unless an exuvial 'scalp' is present), the genu is sometimes large and the dioxal fissure is sometimes secondarily lost or masked by a gnathosternal rectum. The recognition of the encompassing of the trochanteral pedestal as a diagnostic character state makes easy the identification of members of the Planofissuræ, and even if the somal integument is opaque, the external absence of any substantial part of trochanters I or II is ascertainable. Therefore, I now prefer to have this monophyletic taxon as a named group within the classification. There is a considerable disparity between its large size (over 100 families) and the size of the Clinofissuræ (Lee 1985: 50 — 6 families), the only other section within the Holosomatina. It has been given a new name to match that of its sister group and to emphasize its new lower rank. The Circumdehiscenciae is currently regarded elsewhere as one of seven cohorts within the Cryptostigmata (Johnston 1982), or as the Fuoribatida, being one of two suborders of Cryptostigmata (Balogh & Mahunka 1979).

The Planofissuræ generally includes two major groups; the Gymnonota (Pycnonoticae or Apterogastrina) and Poronota (Poronoticae or Pterogastrina). Previously I (Lee 1985: 49) reintroduced the use of Pherenotae for some members of the Gymnonotae. The Gymnonotae is further divided here so that the Planofissuræ includes the following five subsections with their characteristic superfamilies; Pherenotae (Gymnodanaeidea); Carinotae (Liacaridea); Gymnonotae (Oppioidea); Pliconotae (Tectocephoidea); Poronotae (Oripodoidea). This is intended to undermine a tendency in past classifications to represent the evolution of the Planofissuræ as a linear progression from the primitive Pherenotae to the advanced Poronotae. It is possible that three distinct lineages or subsections were derived from the Pherenotae, two of them monophyletic (Carinotae and Gymnonotae), whilst the Pliconotae may have given rise to the Poronotae. Such a model may prove inadequate, but it currently aids the search for alternatives to using the Gymnonotae as a large, probably polyphyletic taxon.

Superfamily ORIPODOIDEA Jacot

Oribatuloidea Thor: Woolley, 1958: 870 (part).
Oribatuloidea Thor: Balogh & Balogh, 1984: 257.
Excentrosclerosae Grandjean: Trávě, 1970: 209.

Nominotypical family-group; Oripodinae Jacot, 1925: 277.

Remarks

Dr R. A. Norton (State University of New York, Syracuse) has pointed out (pers. comm.) that Oripodidae is the senior valid name for any family grouped in the Oribatuloidea: Balogh & Balogh, 1984. The principal of co-ordination (Article 36, current Code of Zoological Nomenclature) requires that Oripodoidea is the senior available superfamily name and is valid for the taxon.

The Oripodoidea is one of the biggest superfamilies in the Cryptostigmata. No clear delineating diagnosis has been made for the adults. They usually have small fixed pteromorphs, but these structures may be either large and hinged or absent, and even the foramina (diagnostic of the Poronotae) may be absent. On the other hand, immatures may be diagnosed by being 'nymphes à microscélrites' (Grandjean 1954) later referred to the 'Excentrosclerosae' (Grandjean 1959). The replacing of 'Excentrosclerosae' by a superfamily name was considered by Grandjean (1959: 473), but he was concerned about the similarity of the included Mochlozetes to members of the Ceratozetidae. Later, however, he considered (Grandjean 1960) that Mochlozetidae Grandjean 1960 were similar to Sellnickiidae Grandjean, 1960 and also, Trávě (1970) added Parakalummiidae Grandjean, 1936 to the 'Excentrosclerosae'.

Subfamily PSEUDOPPIINAE Mahunka

Pseudoppiinae Mahunka, 1975: 293.
Constrictobatinae Balogh & Balogh, 1984: 280.

Type-genus: *Pseudoppia* Mahunka, 1975.

Diagnosis (Adults)

Planofissuræ. Poronotae. Oripodoidea. Oribatuloidea. Proteronotal seta ≤ 1 shorter than $j1$. Lamellae usually absent (exception: *Constrictobates*). Hysteronotum pear-shaped, sejugal furrow extending anterior to bothridium (around seta ≤ 2), may be evanescent or absent across mid-line. Hysteronotal setae in 11–15 pairs (always 6Z), setose (may have small cilia), not as long as distance between bases. Two pairs of hypertrophied slit-like pores ($h/3$, $h/6$) present. Either two, three or four pairs of small multiporose foramina present. Pteromorphs, if present, inconspicuous. Intercoxite apodemes transverse, short, not crossing midsternal line or reaching margin of genital aperture. Genital shield with two or three pairs of setae (exception: *Phauloppiella* with 4JZg).

Remarks

Balogh & Balogh (1984) ignored the part of the original diagnosis stating 'One pair of very small

area porosae' were present and regarded *Constrictobates* as 'Sacculonorie', whilst this paper records three pairs of multiporose foramina (= areae porosae). Therefore, *Constrictobates* should be grouped in the 'Poronorie' Oribatulidae rather than the Fenecheliidae. The options were to either maintain the *Constrictobates* in the monotypic Constrictobatinae, to group it in the Pseudoppiinae or to disregard these subfamilies and place it in the large, diverse Oribatulinae. Relationships in the Oribatulidae are poorly understood and the maintenance of many small subfamilies is not advantageous, yet there is a group of genera including small species with few genital setae, an anterior extension of the hysteronotum into the proteronotal region and many hysteronotal setae. In order to recognise this group, Pseudoppiinae is considered valid and the Constrictobatinae its junior synonym. The delineation of this more extensive concept of Pseudoppiinae is open to argument. To follow the weighting by Balogh & Balogh (1984), the number of genital setae would be regarded as the most important diagnostic characteristic of the subfamily, but genera such as *Diphauloppia* Balogh & Balogh, 1984 and *Paraphauloppia* Hammer, 1967 with only two or three pairs of genital setae are excluded, whilst *Phauloppiella* with four pairs of such setae is included. This results from a weighting in preference of the number of hysteronotal setae because of differences in chaetotaxy (for example compare *Paraphauloppia*-3J, 5Z, 2S with *Senoribula*-2J, 6Z, 3S) as well as total number. The following five valid genera are included in the Pseudoppiinae: *Constrictobates* (see following); *Phauloppiella* Subías, 1977 (Spain-Pm); *Pseudoppia* Pérez-Inigo, 1966 (central Spain, east Pyrenees-Pm); *Symphauloppia* Balogh, 1972 (Bulgaria-Pm); *Senoribula* Mahunka, 1975 (Senegal-Ee near Pm). The three genera (*Pseudoppia*, *Senoribula*, *Symphauloppia*) originally making up the Pseudoppiinae are more similar to each other than to the distinctive *Constrictobates* and *Phauloppiella*.

Genus *Constrictobates* Balogh & Mahunka

Constrictobates Balogh & Mahunka, 1966: 559.

Type-species: *Constrictobates lineolatus* Balogh & Mahunka.

Diagnosis (Adults)

Pseudoppiinae. Hysteronotum with 15 pairs of setae (S2 absent), 3 pairs of multiporose foramina (F3, F4, F5). Sejugal furrow continuous across mid-dorsal line. Lamellae present but flattened (seta z1-z2). Minute, horizontal pteromorph bearing setae Z1 and S1. Three prosternal apodeme bases (1, II,

sejugal) present. Anterior margin of genital aperture and acetabulum IV transversely level. Two pairs of setae on both genital (2/Zg) and anal (2/Za) shields. Legs short (order of decreasing length: I, IV, II, III) tarsi only about twice genu length, three pretarsal claws.

Remarks

Constrictobates includes one species previously recorded only from Western Australia. It was established in the Oribatulidae and, after being grouped in the Fenecheliidae by Balogh & Balogh (1984), is now returned to the Oribatulidae (see Remarks on Pseudoppiinae). The material from South Australia is described here and compared with type material to correct original description inaccuracies and indicate intraspecific variations. The South Australian specimens are smaller and usually have a few character states differing from the type series, but not in all cases.

Constrictobates lineolatus Balogh & Mahunka (Figs 3-8)

Constrictobates lineolatus Balogh & Mahunka, 1966: 561.

Female

General appearance and measurements: Minute to small, dull yellow brown, cerotegument inconspicuous (sometimes evident as a granular, translucent layer partly detached around leg bases or posterior somal margin). Somal setae, other than proteronotal file 1 and 2, medium length but fine and inconspicuous. Somal integument covered in fine furrows forming a reticulate pattern (Fig. 5), but superficially appearing as longitudinal striae, with only limited smooth patches (rostrum, lamella region and a pleural strip on ventral shield lateral to seta Sa1). Idiosomal length 207 (25 ex Tamboore, 183-217); 213 (1 ex Ferris-McDonald Reserve); 228 (holotype and three paratypes). Appendage lengths (for 213, ex Tamboore)-I 88, II 72, III 68, IV 79; tibial heights-I 15, II 9, III 10, IV 10.

Prosternum: Mentotectum width variable, narrow (Fig. 4) to broad (~ setal base distance 11-11). First apodeme base conspicuous, beside apodeme bases some faint external ridges between coxite zones. Coxisternal setae with seven pairs on flat mid-venter (J2 large) and two pairs on lateral tecta (J3 pedotectum 1, J13-discidium).

Proteronotum: Rostral margin tripartite. Lamella flattened (regardable as costula) extends anterior to seta z1 and posteriorly notched between it and circumbothridial ridge, which has hyaline flap ventral to seta z2. Three stout setae (j1, j2, z1) all ciliate, conspicuous proximally on abaxial surface of j1, inconspicuous on j2 and z1. Seta j2 finer than

z1, but sometimes similar in length (not as Fig. 3). Fine furrows restricted to near seta j2 and shallow groove between setae j2-j2 (Fig. 5). Seta j1 at anterior end of short ridge. Seta s2 inconspicuous, fine about a third length of j2, ventral to z2. The sensory seta z2 varies from clavate to capitate (Fig. 8), with cilia in longitudinal files, and often fewer on globose head of capitate state, also transverse profile may be either circular or oval.

Opisthosternum: Genital shield only slightly anteriorly transposed into region between leg acetabula. Substantially unpatterned lateral strip on ventral shield (Fig. 5) abaxial to seta Sa1. Considerable variation in relative positions of seta Sa2 and pore Saf (Figs 4, 7), with commonest state on South Australian material being Saf parallel to and hardly extending anterior to anal aperture, whilst base of seta Sa2 about level with posterior end of pore (Fig. 4). Posterior setal pair (Sa3) on protrusion of ventral shield.

Hysteronotum: Reticulate pattern of fine furrows (Fig. 5) divided into mid-dorsal and two lateral zones by a more substantial furrow (Fig. 3), which merges anteriorly with the sejugal furrow. Some variation in length of 15 pairs of hysteronotal setae, seta S1 longest and stoutest, sometimes more than twice length of Z1. Pteromorph minute, sometimes blunt (Fig. 3), sometimes pointed, base of seta S1 central or biased. Three pairs of multiporose foramina small (F4 largest), raised rim, ventral 'blister' with 7-13 pores clustered in middle (Fig. 5), foramina F5 unusual amongst oribatuloids in positioning anterior not posterior to seta Z5. Anterior hypertrophied slit-like pore (h/3) conspicuous, posterior pore (h/6) as long, only small part visible from above (Fig. 3).

Legs: Legs short, longest (I, femur-tarsus) 41% idiosomal length. Tarsi particularly short (all less than tibia, Fig. 6), thick (breadth more than 50% length). Tarsus III with distinctive bulbous base. All femora anteroposteriorly flattened with shallow ventral flange, not bearing ventral setae (e.g. femur II, seta v, Fig. 6). Long flagellum solenidium on tibia I and II. Pretarsal central claw longer and more robust than lateral claws.

Somal inclusions: Ovipositor involuted tube length, 65 (soma 215), three lobes length 20. Bears 18 setae, subequal in size to each other, longer and more robust than proteronotal seta j2, proximal setae (pe) unusually distal in position with tips reaching bases of distal setae (dg). No eggs observed. One to three holes in each female, sometimes translucent and granular (? bacteria), occasionally unrecognisable fragments or spherical spores, rarely multicellular fragments.

Male

Measurements and spermapositor (otherwise as female): Idiosomal length 193 (25 ex. Tamboore,

177-204), 216 (holotype). Spermapositor breadth (anterior-posterior, length shorter) -16, sclerotized bilobed shield length -13, bearing 12 very small (shorter than proteronotal seta s2) subequal setae.

Material examined

Twenty-five females (N1986193-N1986217) and twenty-five males (N1986218-N1986242), leaf litter under banksia shrubs (*Banksia ornata*), Tamboore (35°57'S, 140°29'E), 4.7.1974, D. C. Lee. Holotype male and three paratype females (Hungarian Natural History Museum), leaf litter under dry sclerophyll woodland (*Eucalyptus marginata* and *E. calophylla*), Mt Toolbrunup (34°23'S, 118°03'E), Stirling Ranges, 7.6.1953, G. F. Bornemissza.

Distribution

Australia (Aa). Western Australia; Stirling Ranges, dry sclerophyll open-woodland, 13 adults (types). South Australia; Ferries-McDonald Reserve, mallee-heath tall open-shrubland, 1 female/1 of 8 × 25 cm²; Tamboore, mallee-heath tall open-scrubland, 39 females, 37 males /4 of 8 × 25 cm² (69 adults in one 25 cm² sample).

Remarks

Initially, the South Australian material was thought to be a new species. It has been established that this was because of inaccuracies in the original description of the only valid species and because of morphological intraspecific variation. The South Australian specimens are smaller than the type material but are similar enough to be grouped in *C. lineolatus*.

Important differences between the specimens and the original description are as follows: proteronotum with short rostrum (seta j1 close to, rather than well separated from z1); sejugal furrow complete; 15 pairs of hysteronotal setae (J5 and Z5 overlooked); three pairs of multiporose foramina (two pairs overlooked); two pairs of hypertrophied slit-like pores (h/6 overlooked); hysteronotal seta S1 twice as long and stout as Z1 (described as subequal).

Intraspecific variations amongst South Australian specimens (sometimes between right and left sides) as follows: pore (Saf) and seta (Sa2) beside anal shield mostly as first illustrated (Fig. 4), varies to three other positions (Fig. 7) of which one is as types (Fig. 7c); sensory proteronotal seta z2 usually capitate (Fig. 8a), sometimes clavate as on types (Fig. 8b); size of a number of setae varies (j2, s2, S1), usually smaller than on types.

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KARIARA VIEWS ON SOME ROCK ENGRAVINGS AT PORT HEDLAND, WESTERN AUSTRALIA

BY NORMAN B. TINDALE

Summary

This paper describes, through an analysis of rock engravings at Port Hedland in Western Australia, aspects of Aboriginal economic life and material culture in the area. The carvings were recorded on a 1953 expedition and interpretations are given based on work done then with Kariara and other Aboriginal informants in the region.

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This paper describes, through an analysis of rock engravings at Port Hedland in Western Australia, aspects of Aboriginal economic life and material culture in the area. The carvings were recorded on a 1953 expedition and interpretations are given based on work done then with Kariara and other Aboriginal informants in the region.

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This paper is an example of ethno-archaeological salvage research in that it attempts to preserve the opinions of some Aboriginal people of the Kariara (Kariara), Ngarla, Kurama, Pandjima and Njangamarda tribes of north-western Australia about some of the many rock carvings or engravings present at Port Hedland. These were cut into the rock by earlier generations of Aborigines whose ideas appear to have been sufficiently close to those still held today that Kariara people of the present generation are able to make interpretations of the intentions behind the ancestral work.

Simple images were cut into the flat hard lime rock surfaces which had been eroded during former higher seas. The subjects cover various aspects of Pre-Kariara people's cultural life, their economy, some of the animals upon which they depended for food, and also some dangerous ones faced during their endeavours to win a livelihood from the sea which confronted them with its relatively great daily tides. In the time available for study (recreation intervals over two months), a limited number of the hammered-in outline engravings were copied and there were some opportunities for discussions about them with the Kariara and other Aboriginal people of the wider Hedland area.

To them the old-time engravers were the Minjukururu or Axe-people. This we can link with the Njangamarda term *minjururu* applied to the black volcanic rock used for their own axes.

Two types of hafted stone tools appear among the engravings, both of which were recognised by the Kariara as still in use in 1953. Both are discussed not only for their modes of use but also for their special interest to archaeologists. The stone axes are discussed at some length both as presumptively Pleistocene tools and as ones used today. Resin-hafted discoidal flake stone knives, also still in use and having a history extending from over 30 000 years ago until the present time, are given particular attention.

Evidence points to the particular engravings at Port Hedland as being post-Mid-Recent in origin, so that the Pre-Kariara artists might have begun their work less than 3 500 years ago. It is reasonable to view the makers of these engravings as much like the Kariara of today. Rapid growth of Port Hedland as a shipping port since 1953 is leading to the loss of some engraving sites, and the surviving Kariara folk are losing many of their links with the past. Thus this paper seems warranted.

On 2 May 1953 members of the University of California at Los Angeles and Adelaide University Anthropological Expedition with Professor J. B. Birdsell and this writer, having concluded anthropometric and associated anthropological work at Marble Bar in Western Australia, journeyed by car to Port Hedland on the west coast to set up further field stations among the Kariara and other local tribespeople. At a point near Strelley we searched a granite knoll for Aboriginal campsites and implements but found nothing, save the remains of a baler shell near a very temporary rainwater pool, already dry. Continuing towards Hedland the spinifex *Triodia pungens* plain gradually yielded pride of place to heath-like types of shrub. Port Hedland was reached across a landscape of old estuaries and salt marsh lakes, many filled with mangroves. There are also older dune range shore lines with banks of lime-cemented sand.

The party was met by Mr Harvey Tilbrook, Native Welfare Officer for the Hedland area who, after we had settled in, took us to see some Aboriginal rock carvings on a site about 1.5 km beyond the then little town and situated on some of the smoothly-eroded hardened fossil dune banks to be seen opposite the small local Native Hospital, as it was then known.

The consolidated dune beds there are approximately three metres above the present-day normal highest tide mark and appear to have been swept over in the past by seas from both sides so that they

now form flat, smooth-contoured lime-hardened old coral or dune banks. Usually there are two parallel lines of them close together, with a depression between often filled with brown earth. In other places they appear conjoined as a single line of old dune. There are Aboriginal deposits in the brown earth, chiefly of pelecypod shells, identified by the late Bernard C. Cotton as *Tegillarca besalis* (Iredale). These are present usually directly on the hard surface of the dune. Where this brown layer has been eroded away or is absent, the smooth rock surfaces, extending for nearly 3 km along the line of these dunes, are covered with engravings made by Aborigines. Usually they are shown as lines hammered in with a partly grooved pecking technique as though first marked with a line of punctures and then connected to make continuous grooves. These grooves usually are from about 1.3 to 2.0 cm in diameter and in general depict the outlines of the subject, sometimes with additional lines to indicate decoration. The grooves are not very deeply cut and often have well-worn edges. Only in one small area were there any deeply cut, very fresh-looking ones which might have been long protected by an earthy covering. Figure 39 could be an engraving of the kind of tool used by the old engravers.

The carvings historically may not be very old and the engravings conform to the present contours of the surface, well exemplified in the case of one particular turtle figure where a slight erosion gutter has been incorporated into and affects the outline of its head. The subjects appear to belong to a pre-European period since there are neither figures of ships, nor other designs which could be assessed as foreign, with one possible exception, a female figure, described later in this paper.

The existence of the rock engravings at Port Hedland has been long known. Herbert Basedow (1925) showed some human figure carvings, and Frederick C. G. Rose (1950) depicted others. A detailed account by Frederick D. McCarthy (1962) reported on a great many of these engravings, working from an archaeological point of view, and his account should be consulted for detail. Similar rock engravings are described in *Western Australian Museum Special Publication No. 2* (Ride & Neuman 1964). It is devoted in great part to the story of Depuch Island off the coast near Port Hedland. I. M. Crawford therein illustrates rock engravings from that island, some of which are similar to the Hedland ones, but others are styled as stick figures. Some of the Depuch engravings represent humans in action, often carrying spears. Such designs were not generally evident in the area of the present study, which tend to be of static figures. It is unfortunate that there were no Aborigines surviving on Depuch to help Crawford

in his understanding the engravings. They may not be contemporaneous with the Port Hedland ones. A drawing shown by Crawford (1964: Fig. 7) described as an 'elaborate opening scene, Hunter's Pool' seems to me to match closely the description of a dugong-spearing as given independently by my informants. It shows the long spears, some barbed, and the ring of armed men about an already speared animal. The marine hunting way of life thus appears to have been much the same as today.

THE PORT HEDLAND ENGRAVINGS

At first, work on copying the rock markings was confined to the area near the Native Hospital where we began anthropometric work and a rough tabulation was made of one area, but circumstances led to some random copying of interesting designs elsewhere, and of ones to which our attention was directed by Aborigines. The following list thus is based only on the majority of the recognisable designs present in an area roughly estimated as some 50 × 500 m, made irregular by the presence of several temporary Aboriginal camps for people attending the Native Hospital. In the list relative numbers of carvings could be of some interest as showing the general range of the various artists' thoughts:

Boomerang (plain silhouette) (as Fig. 19)	18
Boomerang (decorated) (as Fig. 28 etc.)	15
Spearthrower (decorated) (as Fig. 14)	3
Spearthrower (plain)	1
Shield (decorated) (as Fig. 1)	4
Shield (simple meander figure on it)	1
Spear (as Fig. 7 etc.)	3
Snake-like design (as Fig. 80)	1
Turtle (as Fig. 73)	4
Shark (as Fig. 84)	2
Ray (as Fig. 75)	1
Bird (as Fig. 59)	1
Bird tracks (as Fig. 66)	11
Kangaroo or euro track (as Fig. 93)	4
Wallaby track (as Fig. 94)	1
Man (as Fig. 48)	1
Bar and lines (as Fig. 99)	11
Designs, complex and indeterminate (as Figs 102, 103, 111 etc.)	17
Axe-sharpening marks	19
Meanders of 2 lines	2
Meanders of 3 lines	1
Meanders of 4 lines	2
Concentric circles (as Fig. 103)	1
Parallel lines (as Fig. 112)	2
'Scraped sticks' (as Fig. 107)	15
Circle (crossed) (as Fig. 113)	1
Fat bodies of fish (as Fig. 76)	1
Human foot tracks 4-toed	3
Human foot tracks 5-toed	2
Human foot tracks 6-toed (Fig. 51)	1
Human foot tracks (indeterminate)	1

As noted, the engraved designs which are illustrated in this paper were not all obtained from the one area near the Native Hospital. Some were selected from several wider areas within the township limits. There was one strange engraving, that of a female figure (Fig. 132) which appeared to be 'foreign'. It is unlike any others I have seen from anywhere in Australia. Strange elements in it include emphasized female breasts with the nipples duplicated, perhaps implying views from two directions. It could be a late accession. Publication of the figure could be considered of dubious value, but perhaps if shown might lead to discovery of further data on its origin. The design was clear cut and the edges of the cuts were sharper than in the generality of the other rock carvings, hence there could be room for debate as to its time of making. Some anthropologists perhaps would wish to ignore such a 'foreigner' — but it did exist in March 1953 and should be noted. Local opinion ascribes it not to Aborigines, but to someone of a small group of American soldiers belonging to a Navajo special unit that was camped close by during World War II. It is the only engraving considered possibly to be of non-Aboriginal design.

KARIARA COUNTRY: AN OUTLINE OF THEIR LIFE

Kariara country extends along the coast from north of Port Hedland west and south to beyond the Yule River. Inland it goes south for at most 150 km to where, in the Yule headwaters, the people meet the Njamal tribesfolk. For further details of their boundaries, see Tindale (1974: 344).

As far back as Kariara tradition goes they have lived at Port Hedland, and very old men talk about early events which had come down to them, of a time before white men had first appeared from the northeast. Malayan fishermen had been working along the coast, seeking trepang even before the first white men had arrived. According to local information, the nearest Malayan anchorages had been in the vicinity of La Grange, particularly at False Cape Bossut in Karadjari country. This was over 400 km away to the north-east. Some Malayan vessels had made visits to the Port Hedland area but there had been little Kariara contact with them.

In terms of the far earlier postulated arrivals of men in Australia, down the ancient corridor across the lowland Sahul Shelf from New Guinea during periods of lowered sea level in the Late Pleistocene, the land of the Kariara was about as remote from the ancient Asian doorway to Australia as could be envisaged. However, according to their own stories (they had been subject to pressure from the eastern Desert interior. People now known to them as the Njamal had forced their way to the sea near Sireley, thereby cutting the Kariara off from their kindred

folk, the Ngarla, who live along the De Grey River. Although now separated they still speak kindred languages and are alike in not having succumbed to the initiatory rites of circumcision and sub-incision brought in by the Njamal and urged on them with great force by the newcomers. In spite of this pressure both Ngarla and Kariara had resisted adoption of any of the secret rites common to these newcomers out of the Desert to the east. From a quick reading of the evidence in the present-day Kariara way of life, their social organization and even their language reflect their isolation, but it is clear they still have had to defend themselves against invading customs.

Some of these ideas were already old if looked at in terms of social organization to be seen in some eastern parts of Australia. The Kariara had adopted, for example, along with many of the other people living on the western coast, the four-section system of social organization, and had abandoned some of the ideas which continued in the extreme south-west, such as the still little-understood kinship system that prevailed near Perth. This switch to the four-section system had been present long enough for it to become locally adapted in many tribes, with some well-rooted changes, so much so that, even within the northern and southern hordes of the Kariara, there were special adaptations, details unnoticed by Radcliffe-Brown (1930: 208) who had come to the view that it was indeed the model for the four-class system. Actually the model he set up is really the form of the system practised today by the adjoining Ngarla tribespeople. Be that as it may, the Kariara in the days when white people first appeared were defending their mode of initiating their youths into adult life without the secrecy of the rites of the men of the Njamal and other inland desert tribes. These desert tribes had adopted the rite of circumcision as a first rite performed in secrecy, away from their women, followed by a further, ultra-secret, second rite of subincision. These two initiation practices seem to have spread independently from the east as they found their way across the desert interior from the north-east. The second rite of sub-incision has usually caught up with the first, as among the Njamal.

The Kariara were faced with resisting the full impact of the Njamal tribe ways of initiation. However, despite their despised position in terms of their Njamal neighbours, they had been able to resist the new ways for some generations. Their southern kindred, the Indjibandi, had succumbed to the first or circumcision rite under pressure from people like the Bailgu who also, coming from the east, had attempted to exert pressure on the coastal people. The full significance of these fundamental life differences is well shown by the lines on the 1974 tribal map published by this writer.

As weapons of defence, the Kariara have only barbed spears with barbs affixed with resin and/or with sinew lashings. These are also their principal hunting weapons. The desert Njamal folk more often use simple, often slightly swollen-headed throwing clubs for most of their hunting needs, spinning them as they attack their prey, reserving their spears, of which they possess many, for use in contention and in acts of aggression. Often the spears are armed with resin-affixed terminal stone-heads instead of the merely affixed lateral barbs of the Kariara spears. The Njamal also use a different spearthrower. On the basis of the engravings on the Hedland rocks it would seem that the Kariara inherited inferior types of spears from their Pre-Kariara ancestors.

Although thus disadvantaged, both the Ngarla and Kariara have been able to resist adoption of the dreaded secret rites, retaining the simpler, openly displayed ['tjilimindi']¹, or arm-binding, and hair-plucking ceremonies of their past to mark the changeover of their youths from boyhood to manhood. However, their southern kin, the light-skinned and blond-haired Indjibandi of the Fortescue River, had been forced, or enticed, in recent years to accept the rite of circumcision. One old Kariara man complained bitterly to us that lately, by making offerings of brides, Indjibandi men had enticed one or two Kariara youths to accept the first secret rite, thus depriving the Kariara of their own men.

Openly displayed as rock engravings at Hedland are some of the decorative symbols, concentric circles and spiral designs, held as secret by inland tribes along with such tools as ['tjimari] or resin-hafted, discoidal knives as used in their initiatory operations. The last named, the *tjimari*, is the instrument for their circumcision rite and is considered to be a particularly important secret object to be produced only at men's ceremonies. Openly displayed as the symbols are at Port Hedland, they cause worry among Njamal, Njangamards, and Bailgu tribes visitors who had discovered them. They might be seen by their women. To the Kariara, however, such engravings remind them merely of openly used paraphernalia of their own initiation days. In discussion they suggest that the initiation rites of the Pre-Kariara artists must also have been open to viewing by both sexes.

Until the changeover to employment as cattle station hands, and more recently as gatherers of rare earth minerals, the Kariara of Port Hedland area were exploiters of the life they found in the sea. They had no watercraft, and walking in water up to their armpits was a limiting factor in their efforts. Fish-spears, held javelin-like, were used, providing one of the principal ways of obtaining their fish foods. Sometimes a man's javelin-like weapon was linked

to his body by rope made from human hair, one end tied around his waist and loops caught under it, ready to be played out as the fish, or other marine creature, was lanced and, trying to escape, dragged the fisherman about until it succumbed. Daily tidal changes enabled the Aborigines to use several other special ways of fishing. One method involved the use of special fish-killing weapons of heavy wood, of boomerang form but biconvex in section. These could be thrown at their prey, usually one of the larger fish, even one as large as a shark, or at a marine mammal, such as porpoise or dugong, especially at times of high tide. If a cast was unsuccessful, the weapon could be retrieved readily at low tide. Nets for catching fish were hard to come by and in the Kariara area came usually in trade from the northeast. According to my informants this was only for lack of local fibres suitable for string-making. Women's hair was the only useful and ready source of fibre for string. An important way of trapping fish, as substitute for netting them, was by using teams of men and women to push walls of beach vegetation through the water surrounding their prey, generally at particular places in estuaries and channels where there were suitable coves or banks against which to trap the animals.

THE KARIARA PEOPLE AND THE ROCK ENGRAVINGS

Kariara interest in the rock markings was apparent when we met our first Aboriginal informant, an old man named ['Kundjin]. He immediately recognised an engraving I had copied (Fig. 92), calling it ['kadarabaga], a whale. Then he discussed two boomerangs (Fig. 18 and 19), saying they were ones used as fish-killers, and that the human figures depicted (Fig. 45 and 48) were of men; others were of women. He recognised the saw-shark as ['irawari], noting that this big fish came into marine lagoons and water channels at high tide and could be speared or killed with the aid of boomerangs. Twelve circles clustered together (actually 13) were a nest of emu eggs (Fig. 69). Figure 14 was the engraving of a decorated spearthrower ['walbara], of the kind he called ['bilbinj]. With the help of this man and other Kariara it became possible to interpret and give names to many of the rock engravings.

Kundjin ascribed the engravings at Port Hedland to ['Minjibururu], the stone axe people, who were 'people like ourselves'. Traditionally the Minjibururu came from the south, long ago, and looked for water at Port Hedland. Many died there. Some *Minjibururu* went to Depuch Island. He said that 'Kariara Aborigines cannot get there now, but in the afternoon one can see them on the island. We can't get to them.' The last statement was obviously in his imagination, an allusion to the

former existence of Aborigines on that island as evidenced by smoke and other signs of living.

Like the Kariara, the Pre-Kariara artist-folk can be inferred to have been a shore-dwelling people who obtained much of their sustenance from the sea. They were relatively sedentary since the demand of the rise and fall of the tides, here relatively great, must have determined their daily round of taking fish and other foods from the sea and from the tidal mangrove swamps that surrounded them. They tell the story of these activities in the engravings they placed on the surfaces of their seaside dwelling places. Their artistic attention was focused to a relatively great extent on their weapons for defence and on the ones for the gathering of food. This interest also extended to the most spectacular of the marine creatures, ranging from whales, *kadarabaga*, the dugong ['*njamina*], sharks ['*ira'dananga*], and even to the fresh-water perch ['*jurda*], which they could take in the Yule River. Other than marine products, emus and their nests of eggs, and the birds which they struck down by launching boomerangs at passing flights, provided ready subjects for their artistry.

There are interesting touches from which we can learn, such as the frequent depiction of the fat-bodies on ray-like fish reflecting a special desire for fat, similar to the cravings of Central Desert men, like the Pitjandjara and Ngadajara, for fat bodies of kangaroos and the fatty meat of dingo pups.

Undoubted similarities are to be seen between some of the present-day drawings (Figs 115-131), made for us by Kariara and by kindred tribesmen, and the rock art figures. Indeed it seems safe to assert that there has been a continuity of tradition of some duration, perhaps even for more than a millenium of past residence there by Kariara-like people.

COMMENTS ON THE ENGRAVINGS

Figures 1-6 were identified by Kariara informants as being of shields, or ['*jata*]. Present-day ones are often carved from the relatively soft wood of *Brachychiton* and may also be from *Adansonia* trees. The wavy patterns carved on the engraved shields are still displayed on both Kariara and Pandjima *jata* (see Figs 123 and 128). Woods suitable for weapons are everywhere hard to get in Kariara country and one of the first tasks of a newly initiated young man was to begin a search for suitable trees from which to take his weapons. Readily accessible trees in clan territory were all claimed as potential sources by others, hence he had to search in remoter parts of the tribal territory for suitable hard woods for clubs, spears and boomerangs, and for lighter woods to make shields. Disputes were readily aroused when an older man

claimed that this or that tree or shrub had already been touched, and thus claimed as his own. Kundjing, our Kariara informant, made a drawing of a Kariara shield as Fig. 123 and Ngoera, a Pandjima man, made one of his own people's ['*jandijiri*] shields from the Hamersley Ranges (Fig. 128).

Spears of the Kariara that were used in serious fighting could be armed singly or serially with stingray barbs and spines of other fish set in resin. Wounds inflicted with them were considered to be poisoned, and in their traditions, all things from the sea were considered dangerous. They have a saying about this: ['*Kutuguru 'kapa 'meida wiriwani*] (sea/ from/do not/play with it).

Several kinds of spears were used in fishing, both in the Yule River and in the tidal estuaries. These constantly active tidal streams carried deep water inland because of the high tidal range, and the spearing of dugong or *njamina* gave them their most favoured source of meat. Taking advantage of these tides, men armed with extra long pole-like spears watched the water as it flowed up an inlet. They tested the water flow by throwing leaves on to it. When the inflow ceased at highest tide they set nets, called ['*parubaru*], bracing them with the poles while men armed with barbed spears awaited the chance of spearing an entrapped animal. At low tide they could readily recover and repair their nets. This description of dugong hunting, developed from Aboriginal descriptions, was later noticed to closely fit a rock engraving which was recorded by Crawford (1964; Fig. 7, p. 59) on Depuch Island off the Kariara coastline.

Kundjing could see little difference between the engraved spears shown as Figs 7-13 and the familiar ones of his own people, for which he could remember no fewer than seven different names, chiefly depending on the types of armature. Figures 115-122 are of pencil drawings he made and brought to me to illustrate his own recollections of and names of the several Kariara types. Although they may seem different in our eyes, this may be due to our interpretation of differences in what he saw as resemblances.

According to other Kariara helpers the spears shown in Figs 7-13 were similar to ones they threw, using spearthrowers as aids in launching them. Theirs were multibarbed and the barbs were attachments. The latter could be of stone, shell, wooden points, or stingray and other fish spines. The resin ['*waruba*], derived from spinifex (*Triodia*), held the barbs in place. Stingray tail spines were used as tips for some spears.

Bifacially worked pressure-flaked points called ['*tjimbila*] came, on rare occasions, as traded objects from the north-east. The informant did not know where they came from, but they had for long been



FIGURES 1-19. Port Hedland rock engravings. 1-6, shields, *jauu*: 1, length 130 cm; 2, not measured; 3, length 81 cm; 4, length 81 cm; 5, length 66 cm; 6, 33 cm. 7-12, spears, *talamara*: 7, length 110 cm; 8, length 150 cm; 9-11, not measured; 12, length 91 cm; 13, spearhead; 14-17, spearthrowers, *walbara* also called *hithing*: 14, length 91 cm; 15, not measured; 16, length 76 cm; 17, not measured. 18-19, fish-killer *waruwaru*: length 53 cm and 38 cm.

ascribed to ['Waijungari], a mythical man who also came from the same easterly direction. A few Kariara men had placed them on their spears, but 'only for show'. When white men first arrived, appearing from the same direction, they fell heir to the name Waijungari, and Kundjing recalled the beginning of a song about the pressure-flaked blades: [Tjimbila:na waijungari] (repeat).

Tjimbila blades were not shown on any of the Pre-Kariara engravings of spears, hence there is a possibility they began to arrive only after Pre-Kariara days. A Njangamarda man said that in their country, further to the northeast, *tjimbila* points came regularly in trade. With them came a special very long spearthrower known as a ['gabalinj], also called ['gaballj], and illustrated in Figs 129-130. Tjimbila-armed spears launched by *ngabalinj* were much dreaded — the reason: 'One cut and you bled to death'.

In the days when white men were fighting with Aborigines, this informant said, the police ordered all *tjimbila*, many of them made from introduced bottle glass, to be destroyed, and they confiscated all spears armed with these Kimberley blades.

It should be noted that in South Australia among the Jaralde the name Waijungari is that of a skilled ancestral spearsman, son of their great being Nepele. Waijungari, newly initiated, escaped with two of his father's younger wives and fled to the heavens, as told in a detailed myth (Tindale 1935). At the present time it is difficult to imagine any direct link between these two far-separated uses of the name Waijungari among people living over 2500 km apart. If proof of substantive relationships were to emerge, it would surely imply that the earlier counterparts of the well-known Molonggo, the Kurangara, and similar travelling ceremonies, such as those which accompanied haler shell ornaments for spearthrowers from Cape York Peninsula to Winton in Queensland, and even as far as the Lower Diamantina area, had the power to carry ideas and words with them. Pearl shells from the vicinity of Broome, similarly, but perhaps in less organized fashion, are carried even as far as Ooldea (Tindale, in press). Such inter-tribal exchanges perhaps have had greater influence on cultural shifts and introduction of new ideas than some have suspected.

Spearthrowers depicted by the Pre-Kariara people, as in Figs 14-17 were recognised by Kariara men as being similarly shaped, with a peg orientation the same as in their own spearthrowers or *walbara*. It called for the use of a particular grip in holding spear and spearthrower in position for launching the weapon. For this the handle end of the *walbara* is held between the thumb and index finger and firmly gripped against the palm of the hand by fingers 3, 4 and 5. Tips of the thumb and index finger support the spearshaft so that the peg of the spearthrower rests firmly in the hole in the butt of the spear. This may be known as Method A. It is widely used in southern Australia. The method they do not use, but which is widespread in the northern parts of Australia, involves the holding of the spearthrower between the index finger and the middle one. This requires not only a different shaped body for the spearthrower but also a different orientation of the peg. This second grip I am calling Method B. The latter is linked in complex fashion with the use of composite spears with head, shaft and slightly angled butt piece, each junction lashed with kangaroo sinews and resin coatings. Its employment enables the spear user to keep his forefinger free to take part in an action assisting the development of spin in the spear as it travels towards its target. Having had opportunities to study the methods and distribution of these spear-projecting ways over much of Australia, I have a study in preparation giving support for this preliminary statement about spearthrowers and their use. As is well-shown in my unpublished film on Kimberley blade-making and

use at Moolabulla and the parallel published description, Tindale (1985), the Method B grip is present among the Djaru and Kinja tribespeople and widely used also in the northern interior of Western Australia. Figure 124 drawn by Kundjing shows the Kariara spearthrower, and Figs 129-130 by Mekata of the Njangamarda tribe shows the long-shafted *ngabalinj* they receive by trade from the Mangala, who in turn receive them from the Walmadjari people of the Christmas Creek area, whom they know as the Tjilwaling folk. The *ngabalinj* requires the use of Grip B.

Boomerangs as weapons were evidently important in the early Pre-Kariara artists as also to our Kariara informants who considered that among the boomerang engravings they could recognise several different types similar to ones they use. The main one used for fighting was their [*wirba*], a distinguishing feature of which seems to be its having the end held while throwing it, slightly longer and less wide than the forward end. Such a boomerang would be identified by marks the owner placed

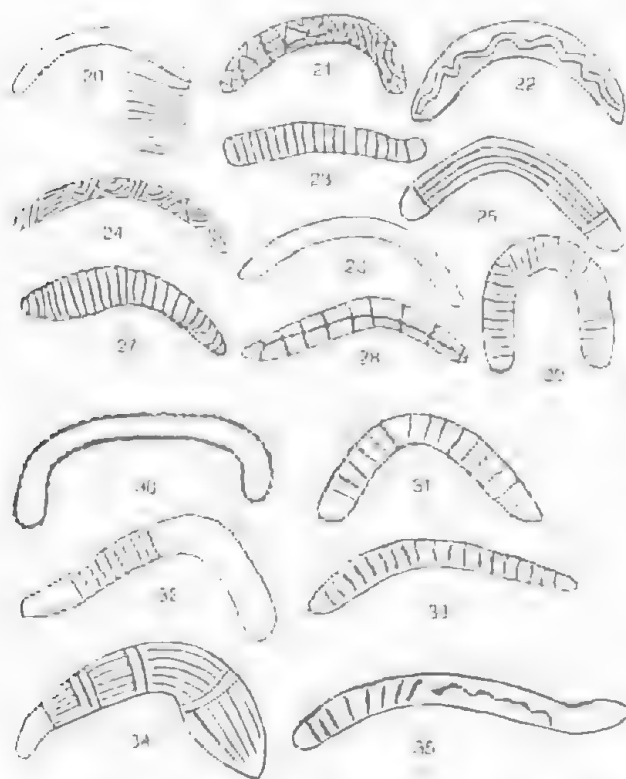
on it. My informant recognised among the Hedland engravings right-handed *wirba*, like Figs 33 and 35, and left-handed ones, Figs 32 and 34. Men who went seeking a fight might carry an armful of *wirba* to combat. Figure 20 was suggested as indicating such a parcel of boomerangs. A comment about this set was that the left-handed owner had not placed his identifying marks on the bundle.

Bird-hunting boomerangs [*wakundi*] were made so they would return to the thrower if they missed their target when thrown into a flock of birds circling to land. It allowed the quick retrieval of such weapons. Opinion was that Figs 28 and 31 were engravings respectively of left- and right-handed *wakundi*.

A special boomerang called [*waruwaru*] by the Kariara was employed in fishing and could also be used as a weapon in close 'arm to arm' (their wording) quarrels. The *waruwaru*, also known as [*waruku:ndi*], was thrown at large fish, such as sharks, and other animals when seen in the water. It had special characteristics and was important in marine exploitation. It was thrown to enter the water spinning vertically, and was bilaterally symmetrical, i.e. had a biconvex section. Such boomerang-like weapons were made of the heaviest of woods so that they would sink and not drift away. They could be reclaimed when the massive tides fell, leaving the area dry. Figures 23, 27 and 31 were ones considered likely to have been intended as representations of *waruwaru*, and Kundjing drew, as Fig. 126, his concept of their own Kariara one. Similar heavy wooden boomerangs for fishing have been used as far away as at Port Lincoln in South Australia, among the Pangkalla tribespeople. In post-contact time examples made of metal cut-outs have been used.

Representations of halted stone axes appear often among the Port Hedland engravings. Perhaps they were highly treasured objects. Kariara men considered them good depictions of their own [*bulbul*] which they said (in English) were always made of 'steel stone'. The present-day Kariara hatchet has a split withy wrap-around handle bound with kangaroo leg sinews [*talbara*], since dingo sinews are too short to be useful. The stone was fixed in the loop of the haft and the lashings held with *waruba* resin which was gathered from spinifex. To obtain this resin the Kariara beat matured clumps of the grass on a hard surface and sweep up the resin flakes and winnow. By holding burning twigs over the dish of flakes they carefully melt the resin at the lowest possible temperature. A bluish smoke indicates over-heating, rendering it brittle and useless. The melted resin is gathered up on a stick to form a ball ready for use.

Kariara axe stone came to them by trade from the northeast beyond Njama country. Each block

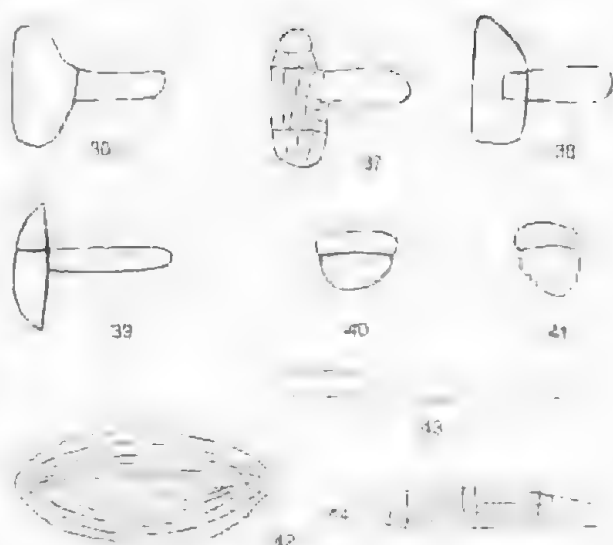


FIGURES 20-35, Hedland boomerang engravings, *wirba*. 20, length 41 cm; 21, length 53 cm; 22, length 41 cm; 23, fish-killer, *waruwaru*, length 43 cm; 24, length 48 cm; 25, not measured; 26, length 53 cm; 27, fish-killer, *waruwaru*, length 46 cm; 28, left-handed returner, *wakundi*, length 46 cm; 29, length 25 cm; 30, length 48 cm circular holes are subsequent; 31, fish-killer, *waruwaru*, length 38 cm; 32, left-handed returner *wakundi*; 33, fish-killer, *waruwaru*, length 43 cm; 34, left-handed returner, *wakundi*; 35, right-handed returner, length 51 cm.

had to be edgeground to make a cutting edge by rubbing it on hard rock surface such as granite. It happened that Windaru, an aged Njangamarda man from further north, who was visiting the Native Hospital, was with us on one occasion and heard Joseph Birdsell remark on the seeming shortness of the handle of an axe depicted in one of the engravings (Fig. 37) that we had just noticed. The old man's response, using his own name for the axe, was brief and to the point — 'Heavy ['ma:di], short handle'. The present-day stone tomahawks tend to be smaller and have long handles. Another Njangamarda man of the coastal country further north said that their *maadi* axes were made from ['minju'ruru], literally his 'black stone', which came by way of trade from the hills southeast of ['Jalajala] or Eil Eil Spring. Thus it may have been traded to Port Hedland from more than 300 km away. The engravings of axes unfortunately do not tell us much about the work done on the axe heads during their making, and whether or not the hafting was held in a groove. The presence of heavy axes with short handles might suggest that more and heavier timbers than grow nearby today were available locally in Pre-Kariara times.

Figures 40 and 41 were pointed out to us as representing resin-hafted discoidal stone knives called ['tjimari] or ['jimari]. One was depicted as larger than ones used by the Kariara people today. Both sexes could use them for general purposes as unifacially knapped knives with resin handles. Since good chert was not locally available, women often used instead a similarly shaped *Cyrena*-like bivalve shell for their food preparation work. The situation was different among the inland tribes to the east and south, particularly the Njamal, Njangamarda, Niabali, Indjibandi, Kurama, Pandjima, and Wanman who, using the stone flake knives in their secret rite of male circumcision, have come to regard the *tjimari* as one not to be seen by women. In several papers, particularly Tindale (1957: 15; 1965: 143; and 1985: 28) I have reported the discovery of the various surviving uses for this knife, which is of special interest because it is recognisable as one of the principal tools found archaeologically in horizons as far back in time as the 30 000 BP era in eastern Australia, as well as being one of the dominant tools of the Newer Tasmanian culture. It was one of the cutting tools of the Tartangan culture phase (of Hale & Tindale 1930). There is further discussion of this *tjimari* tool in the concluding part of this paper.

It will be noticed that while very many of the rock engravings are of items and subjects of interest particularly to men, a few relate to implements used by women. Perhaps there was some bias since the informants did not recognize all of the designs. It happened that they all were males. One engraving



FIGURES 36-44. Hedland tool engravings. 36-39, hafted edge-ground axes, *bulbu*; 40-41, resin-hafted discoidal flake knives, *tjimari*; 40, diameter 18 cm; 41, diameter 9.5, of resin handle 10 cm; 42, wooden dish for winnowing; 43, beater for opening termite mounds, length, 74 cm; 44, throwing club *wambu* (Ngarla name), length 61 cm.

(Fig. 44) was recognised by them as a ['lumba] or beating-club such as used by women in breaking into the numerous tall meridionally-oriented termitaria present on the *Tiodlu* grass-covered plains situated a little inland from the coast. Termites, called ['maladja], were one of the foods gathered by women, using wooden dishes, called ['tjardu], to separate termites from the soil by rocking and winnowing techniques. Figure 42 was interpreted as an oval-shaped *tjardu* with riffles cut into the surface to assist in the effects of the tapping, rocking and other manipulations which help clean the product and yield a whitish mass of crushed termites used as food. Such dishes were used also by men in winnowing resin for their weapons.

Human figures were not common in the carvings of the area near the hospital and did not seem to display the same considered detail of some other carvings. Figure 45 was thought by Kariara informants probably to represent a youth. Taking note of the differences in the arms of the boy the informants believed him to be in the stage of initiation when he was undergoing an arm-binding rite. His left arm was interpreted as being badly swollen by too much pressure while the right was lean and firm-muscled, as was proper. Following up this lead we obtained details of the Kariara initiation. When a youth is about 14 or 15 years of age he is seized as a ['malulu] by a group of men who became his ['mamia]. In their four-section system of social organization, if the boy is a Paljeri or a Purungu his *mamia* are of the opposite moiety (Karimara and Panaka), who call him ['piruwan].

The men of the boy's own, the inactive moiety, become his ['kangu] and they call him ['walara].

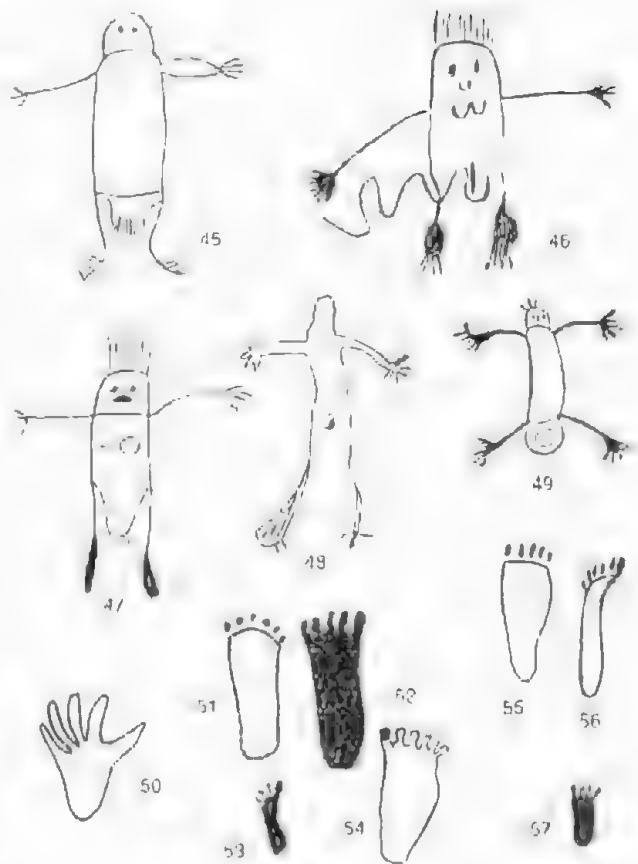
The *mamia* take their *piruwang* on a tour through their country during which he is told much about the history and the names of places and he also learns of the responsibilities he will be assuming as a man. At this stage the boy wears a small pearl shell ornament ['pira'pira], suspended from his neck, and another over his pubic area. Messengers with him ask people of other hordes of the tribe (met during the *malulu* journey) to assemble at an arranged time and place for dancing displays. Meanwhile the *kangu* men remain at home working, particularly through their women, building up food supplies against the day when the *mamia* party returns and other invited people arrive. Then there is a ['pundulu], or feast, with singing. Men seat themselves in the centre holding the youth (or youths if, as is usual, more than one faces initiation at the one time). Women dance around the men on the outer side of the circle. This is the climax of their share in the proceedings. Then the *mamia* continue on a second stage in their travels.

The youth during further travel has to undergo the beginning of the ['tjilimindi] or arm-binding ordeal. During this ceremony the men who are his *mamia* sing:

['tjilimindi	mind	wawila	tora ²	kulbarba	tanai
Armbands		winding	blood	swelling	
kulbarba	['janat]				
swelling					

Stings made from the fur of the ['wadiwara], or kangaroo rat, are wound tightly around both of the boy's upper arms and are left for 'six days' and then taken off. If the arms swell too much the bindings are slackened a little. During this stage he is a ['wamuli]. His hands become numb but he is compelled to keep 'travelling on'. He is not allowed to swim. When they come to water the youth is carried across it, for the arm bands must not be allowed to become wet. When these bands are removed his muscles are supposed to be small and solid and he is so strong that he can throw a boomerang very far. The youth is painted with red ochre and is shown the secret of the bullroarer ['kuliedi]. He is now ['mai'jaga], a man. He makes a triumphant return to his people.

In the main there was little comment from the Kariara about the other human figures. Figure 46 was considered to be that of a woman and a snake. It was a visiting Njamal man who expressed the view that the artist had given an action picture of a ['kolibri] or poisonous snake attacking a woman. This chances to be one of the rare Pre-Kariara carvings in which the engraving is not of a static situation but of a real life one. Among the other



FIGURES 45-57, Hedland engravings of humans. 45, man, considered a youth, undergoing the *tjilimindi* arm binding rite during initiation; 46, woman, *manu* and *kolihiru*, a poisonous snake; 47, woman; 48, man, *mai'jaga*; 49, girl child; 50, hand, *maro*; 51-57, footprints, *tjina*.

carvings Fig. 49 was believed to be that of a female child. The genital area happened to be carved around a pre-existing hole in the rock.

In the human figures and in the human tracks the depicted hands and feet have fingers and toes shown with much variation as to number, ranging from four to six. The Kariara had no explanation for these variations. In the case of footprints there seemed to have been no preference in depicting either right or left foot imprints. From the way the Kariara discussed the depicted foot tracks I gained the impression that they thought each of the engraved footprints was registering something special about some individual, recording peculiarities of gait and toe position that were important as aids to identification of individuals which could affect their own daily lives. What mother-in-law would willingly place her own track in juxtaposition to some registering movements of her daughter's husband, with whom she could never openly meet? One human and interesting point came out. Sometimes a distinctly shuffling gait, destroying the legibility of footprints, was a precaution taken as

a woman neared a 'dangerous place', one where such kin were likely to have left visible tracks.

The Pre-Kariara artists depicted birds, usually of the larger and more edible species, and their eggs. I received some help in identification. Figure 58 showed a crane [*tjangara*], and its tracks were considered to be as shown in Fig. 62, while similar tracks, Figs 61, 64, 65, were thought to be those of ibis, more than one species of which live in the swamps. Owls, of which we found two engravings, are in some fashion linked with present-day stories, but I failed to follow up because of pressure of other recording. Kundjing, our first Kariara informant, recognized the subjects of Fig. 66 as a set of the eggs of the emu [*tjanguna*]. In egg-laying season the emus were not molested, but the eggs were taken. At other times of the year emu and kangaroo were hunted, using fire to drive the animals toward strategically placed and concealed spearsmen. The

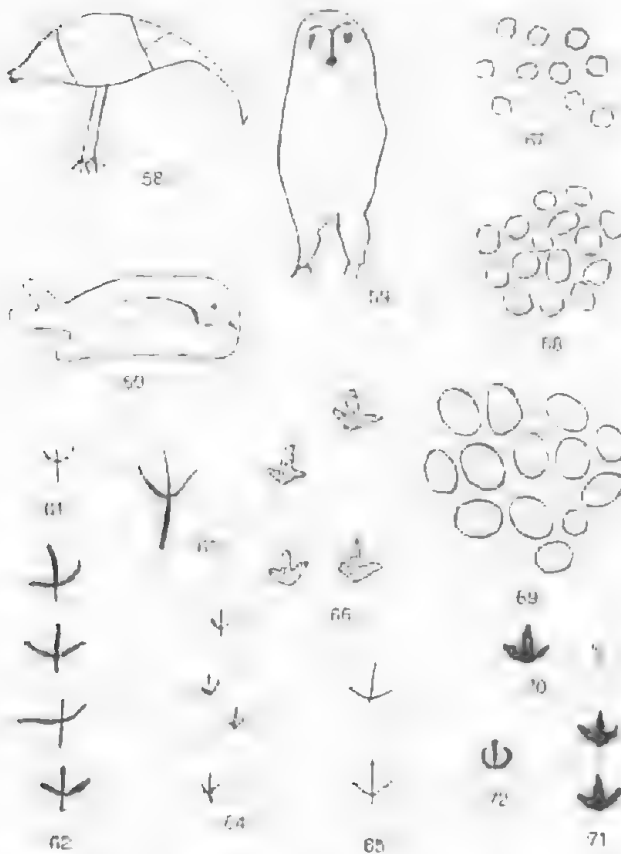
eggs shown in Fig. 67, occupying a space some 30 cm in diameter, were believed to be those of ducks, but I did not follow the discussion as to which kind they might be. Emu tracks are commonly depicted (Figs 66, 70 and 71) and one solitary track, Fig. 72, was thought to be that of the bustard [*ranguriti*]. The neighbouring Njamat people, who had access to better fibres for string, trapped the birds, making nets to enclose native plum trees, the fruit of which were very attractive to the birds. The Kariara were never able to do this netting for lack of the necessary string for making nets.

All food animals played important roles in the thoughts and lives of the early artists of Port Hedland. We chanced not to copy any engraving of the large monitor lizards which were commonly depicted. Of the smaller lizards there were seemingly very few representations among the carvings. Such creatures today are chiefly gathered by women and children hence were perhaps not subjects for men's thoughts.

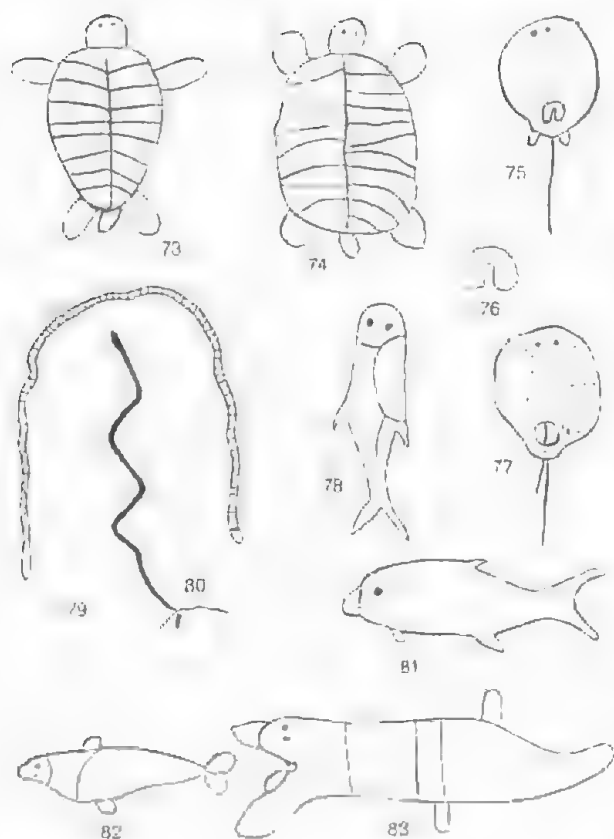
At all times these lesser animals provide a substantial part of the Kariara children's diet. With reference to the larger lizards, it should be mentioned that there is a curved wooden club in the South Australian Museum collection, specimen No. A 46268, received without data other than a general indication of having come from Western Australia. It came in 1964 from the estate of Mr H. Savage. Figures carved on its shaft include one of a monitor lizard, two human figures, and also one of an owl, one that is virtually identical with Fig. 59. These are so similar to the rock engravings being described here that it is difficult to believe that the club could have been carved by other than a Kariara man, one personally familiar with the very engravings present at Port Hedland itself. The work was done on the hardwood surface of the club, first by incision, and then finished by a burning technique. Perhaps this club should be regarded as providing an indication that the Hedland carved designs include some that are not very old, or alternatively that the old artistic tradition continued until a time as recent as a generation or two ago.

Snakes were frequently depicted by the Pre-Kariara artist. The supposed action picture shown in Fig. 46 has already been discussed. Figure 79 was interpreted as that of a python called [*manjara*] and described as possessing a striped pattern and a black head. This type lives in swampy areas. There was another python known as [*palgumara*] living in rocky places around permanent sources of fresh water.

Turtle figures were commonly engraved. Figure 73 shows one of normal size. It should be noted that, in general, designs adhere to expected sizes, however, Fig. 74 does depict a very large turtle, measuring far larger than usual. Although executed



FIGURES 58-72. Bird engravings. 58, crane, *tjangara*, length 66 cm; 59, owl, height 58 cm; 60, owl, length 28 cm; 61, ibis track, length 10 cm; 62, crane, line of four tracks, each about 20 cm; 63, 25 cm long, not recognised; 64, ibis tracks, group of four each, 7 cm; 65, ibis, part of line of ten imprints; 66, emu tracks, *tjanguna*, set of four, length 9.5 cm, showing pecked hammerings; 67, duck eggs, diameter of setting 28 cm; 68, emu eggs, nest set of fifteen; 69, emu eggs, thirteen, diameter of nest space about 50 cm; 70, emu track, length 18 cm; 71, emu tracks set of two, 25 cm apart.



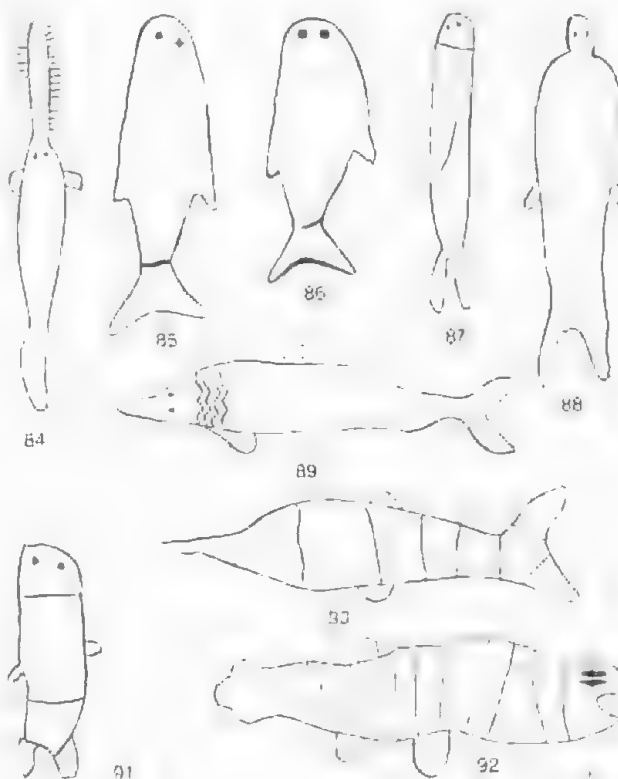
FIGURES 73-83. Reptile and marine-animal engravings at Port Hedland, 73, turtle, *tjatjaroka*, overall length 83 cm; 74, turtle, large, length 1.65 m; 75, stingray, body length 58 cm; 76, fat body of ray 13 cm; 77, stingray, body length 61 cm; 78, fish, 60 cm; 79, python, *mantara*, identified by its banding and black on head, length 3.35 m; 80, snake, not identified, length 94 cm emerging from hole; 81, fish, not identified, length 80 cm; 82, marine mammal, length of body 61 cm; 83, shark, *maritjawarin* of Ngarla tribe, length 2.5 m, supposedly benign.

by artists not in any way linked to each other, these two turtle figures are remarkably similar in execution. Both were considered to be [*tjatja'roka*] by Njibiri, a man of the adjoining Ngarla tribe. He said that his own people were skilled fishermen, able to swim up to a turtle, take hold of the shell at its neck, overturn the animal, and then wrestle with it in a swim back to shore.

Kariara identification of some marine creatures was not always positive. Recent generations largely have had to abandon the gathering of marine foods in favour of work with Europeans. But some details they remember seem important. They appreciate the value stingrays had, both for the early artists and for their own activities. These and other fish provided them with spines for spear tip armatures; the serrated tailspine is still used for various cutting purposes, while their fat is much sought after as food and for rubbing on their bodies as protection against the sun and for decorative purposes. Kundjing drew particular attention to the picturing

of these internal fat bodies as if they were externally visible, and to other examples engraved separately on a large scale, as in Fig. 76. The Port Hedland artists, when drawing fish and other marine animals, seemed habitually to show both eyes. An exception is in the unidentified fish seen in Fig. 81 where an unusual side view of the creature is given.

Figure 82 appears to represent a pinniped mammal and it is possible that the engraving records the existence of fur seals in the Hedland area during the times of the Pre-Kariara people. Figure 83 was considered by a Ngarla man to be a small and benign shark, good for eating, and he named it as [*maritja'warig*]. The same edible quality was ascribed to the saw-shark shown in Fig. 84. Incidentally, in the Fitzroy River, further north, such saw-sharks during flood seasons may go far inland for nearly 200 km, and may become permanent inhabitants of the large freshwater lagoons often present there. One such saw-shark was shot by Joseph Birdsell while on a hunting trip during our stay at Liveringa Station. Figures 85 and 86 possibly



FIGURES 84-92. Fish and marine mammals. 84, saw-shark, *irawari*, length 160 cm; 85-86, fish, Australian salmon-like, lengths of both 106 cm; 87, fish, gurnard-like, 76 cm; 88, not identified, length 160 cm; 89, unidentified, perhaps shark, length 100 cm; 90, Dolphin-like, length 335 cm; 91, doubtful, 'saltwater fish' of Jabili, body length 86 cm; 92, whale, *kadarabaya* of Kundjing, the *purukulana* of the Ngarla, length 2.5 m, kangaroo tracks in place for eyes are a subsequent addition.

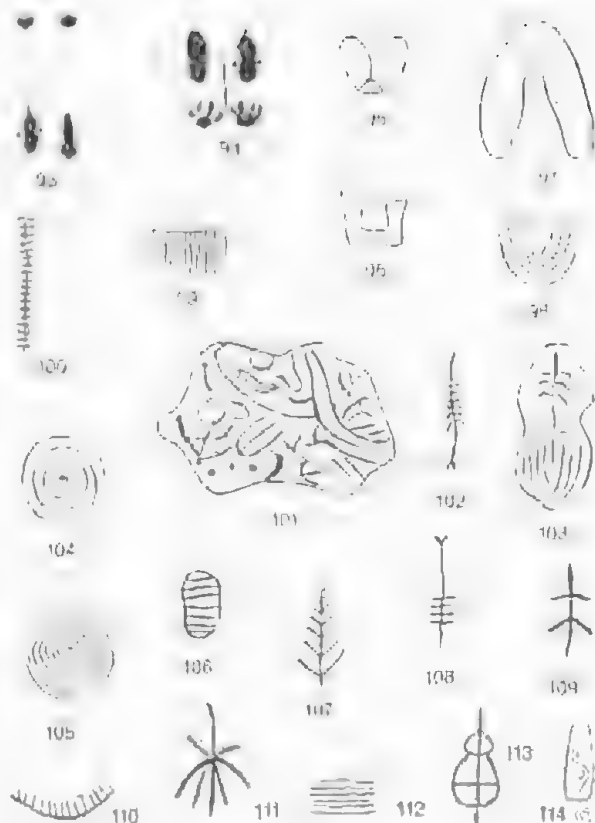
represent a salmon-like fish of large size, and Fig. 87, unidentified, seems to have long pectoral fins much like a gurnard. Descriptions of dolphins, for which they could not at the time recall the Kariara name, applied to Fig. 90, while Fig. 91 was of a fish, perhaps a hexantheid shark. Figure 92 represents the whale engraving which Kundjing spoke about when we had our first conversation with him on the Port Hedland carvings. He called it *kudarahaga* in his southern Kariara dialect, and other men afterwards used [*kararabuka*], the Port Hedland version of the same name. It will be noticed that in the whale engraving a pair of kangaroo foot tracks were cut over the area where eyes originally might have been present. Younger men expressed regrets that feasts of stranded whale had not taken place during their time. Evidently older people had fond memories of such feasts.

Kangaroo tracks frequently were the subjects of the old artists, often, as in Fig. 93, emphasizing the deep impressions of the hind legs made in places favourable for registering such prints. Figure 94 depicts another set of prints in which the forepaws suggest a moment of slow feeding (at such a time the animal would be a better target). In the latter example there was a human footprint carving and also a long spear-like groove 2.8 m long. The juxtaposition of these three elements may suggest that they had been placed there to record a hunting episode but, as emphasized elsewhere in this report, such combinations implying action are rare as compared with isolated static images.

Entirely different are the impressions on the ground representing human beings, as in Figs 95 and 96. They both register the imprint made by a squatting or seated person. The first represents a man, and the somewhat more formal one happens to indicate a woman, as registered by the digging stick which is shown in her lap. Figure 98 was interpreted as a seated man with bird down or feather ornamentation fastened to his body with blood, as might be the case when he was decorated for a dancing display. There was dispute as to Fig. 97 which was carved much too large to be a normal-sized man's sitting imprint.

For lack of opportunities some of the smaller drawings were not identified, but more than one informant suggested that Fig. 99 represented a fur string genital cover, either of the fur of the kangaroo rat or of the opossum. This type of pubic cover was used by Kariara persons of both sexes, especially when flies were more irritating than usual.

The original of Fig. 100 was thought by Kundjing to represent a necklace made of pieces of shell stuck onto a hair string base using resin. Later, when working with Jammi, a Kurama man from the Hamersley Ranges, far inland, we learned that during secret ceremonies initiated men there often



FIGURES 93-114. Impressions, decorative designs, and symbols. 93-94, kangaroo, *waringara*, foot tracks; 95, buttock imprint of man (small carving, width only 23 cm); 96, woman with digging stick (small carving, width only 13 cm); 97, not recognised, 90 cm long; 98, buttock print of feather-decorated man, width 20 cm; 99, fur string modesty shield, width 23 cm; 100, necklet, length 38 cm; 101, much debated shield or skin design, length 84 cm; 102-103, body designs; 104-105, spiral and circular designs representing totemic homes or places, diameter 25 cm; 106, not recognised; 107, whitewood ornament, length 23 cm; 108, body design, length 30 cm; 109, lizard, length 25 cm; 110-113, not recognised; 114, shield with *maini* marks, length 95 cm and circular totemic design *ngorinj mimburu* newly incised by Jabili (white name Dick) of Njangamarda tribe, on 19 May 1953.

wore necklets made of pieces of pearl shell fastened to a fur string band, or to a hair string choker, by being affixed with porcupine grass resin. The Kurama term for the necklace was [*tjitjarliri*] and the pearl shell came to them in trade from the Ngaluma tribespeople of the Roebourne area by way of the Indjibandi. The Kurama, who in earlier days had no knowledge of the sea, gave mulga wood spears in exchange for the shell ornaments. Good quality mulga (*Acacia aneura*) country occurred in their tribal areas and continued south for a great distance. Their mulga shrubs, called [*kurtjarda*], supplied spear shafts which were better than those available to the Indjibandi. Thus there always was a demand for Kurama spears.

Figure 101 was much disputed. To some it was a shield. Its dimensions were much the same as those of their own shields, but no one made them with ['mani] marks like the ones decorating this one. Later, when we were in Halls Creek, an old man named Ngepal of the Whadjuk tribe from near Perth, on being shown my drawing, had his own thoughts about it. He had been a lifelong resident in the northwest of Australia, following extradition for some long-forgotten youthful offence against white men. He claimed that marks on the strange shield-like carving were similar to the designs on the inner side of decorated skin cloaks such as those worn by his people when he was a boy in his own country. Virtually forgotten, Ngepal in 1953 probably was the last living person of full descent from the Whadjuk tribe of Perth. He provided me with a vocabulary and other details for study (Tindale 1974: 260).

In the engravings at Port Hedland the early artists frequently used concentric circles and spiral designs similar to those shown in Figs 104 and 105. To the Kariara they were ceremonial patterns, known as ['kuri], painted on the ground and on objects for display in various ways during dances in which both sexes could take part. Visiting members of the adjoining inland tribes used similar designs, which were sometimes quite elaborate, but only for secret decorations displayed during initiation ceremonies from which women were excluded. Such visiting tribesmen did not appreciate the open display of the markings on the rocks at Port Hedland, and they feared that their women might see them.

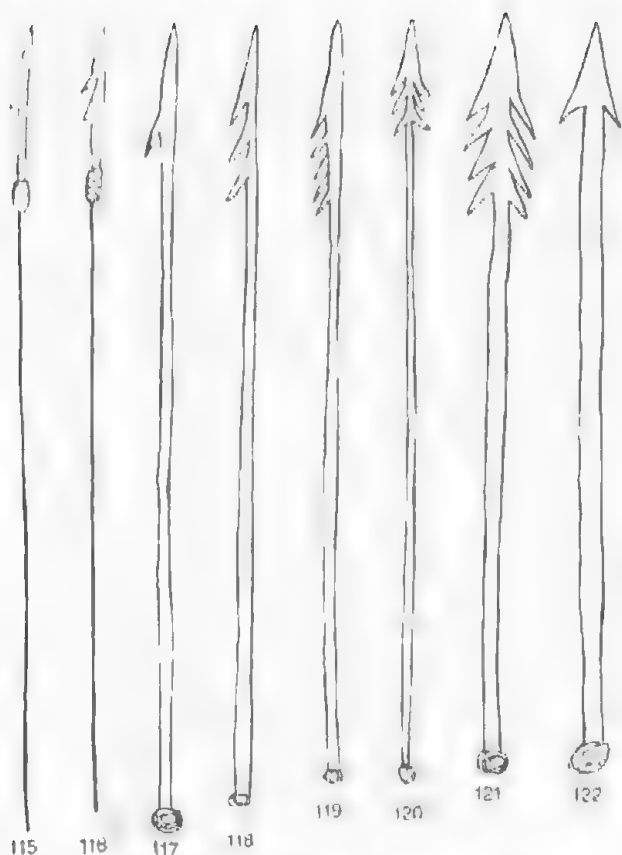
Figure 107 was thought to be an engraving of a ['manggar'manggar], or scraped stick ornament, as made and used by the Kariara when decorating their hair or bodies to take part in displays of dancing before their women and children. The Kariara had no secret ceremonies. These scraped white wood sticks 'looked like flowers'. They were made by scraping masses of shavings from sticks of the *Atalaya* shrub which has a very white wood. Masses of the soft curled shavings became part of wig-like hair dressings. Very often the shavings were left attached to a tapered base stick as they dried they curled up, giving the look of a decorated hairpin. In the same manner, the shavings still attached to sticks could become other forms of decorated appurtenances. A Ngarla man, who said his people also used these *manggar*, supplied a variety of names for them according to their particular uses. A fully dressed Ngarla dancer might wear up to four short decorated pins called ['tjura] in his hair with a longer one ['katjiri] thrust laterally through a rolled or gathered bundle of hair on the back of his head. Still other such ornaments, called ['lijibiri], would be worn around his arms just above the elbow, with one or more, known as ['wambi],

thrust under a belt around his waist. In dancing he might flourish several longer sticks with gatherings of shavings at intervals along their length. These were called ['pilu]. Depending on the subject of his performance, he might carry a boomerang or a spear in one hand and a ['karubinji], or shield, in the other.

Early in our stay I had been copying engravings near the hospital when I had a visitor, an old man named Jabli from Wallal, a Njangamarda of the group living near the sea. He sat and watched for a while and then volunteered some identifications, claiming that he could 'read them all'. He thought he was still in Ngarla country and said that people in his own country also made such marks. He recognised both emu and ibis tracks. Nearby, as it happened, there was a design (shown herein as Fig. 108). This design and similar marks he claimed were placed on the bodies of dancers, and he began to demonstrate, rubbing some limestone on the rock, wetting it with saliva, and painting it on his chest with his index finger. Pointing at a drawing I had already on my card, he identified Fig. 103 as a man's body with the same kind of design he had placed on his own chest. It seemed that these might be considered as personal identification marks. We talked of shields and he said that his people's shields always had ['maini] or ['mani] marks on them, and with a piece of stone he lightly cut parallel zigzag lines on the rock. I made a sketch of this modern addition to the engravings, as Fig. 114. We had been discussing other carvings when I noticed that also he had cut a circle within circle design. Perhaps it was an absent-minded cutting of a ceremonial mark. He called it ['gorin] mimburu] for which I was unable to get a translation. He was returning to Wallal and unfortunately I was not able to see him again.

ILLUSTRATIVE DRAWINGS BY MY INFORMANTS

In my discussions with the Aborigines who helped me to understand their ideas about the Port Hedland engravings we covered other aspects of their life not enlarged upon in this brief study. More than one of them who had no actual model or artifacts to show, chose to use drawings to illustrate their thoughts about the subjects we had been discussing. A few of these drawings are included in this paper as Figs 115-131. Others have been used as part of the background data for this paper. They could warrant a further paper on various ways of life along the coastal country of Western Australia, together with results of enquiries into kinship, language, and story details gleaned as accessory parts of the fieldwork plan on our 1953 expedition.



FIGURES 115-122. Drawings of Kariara spears by Kundjing in illustration of his discussion about Port Hedland engravings. 115-116, called *karuparta*; 117, *karta*; 118, *walakuri*; 119, *tjaran*; 120, *winda*; 121, *wadakutara*; 122, *wadjir*.

Figures 115-122 illustrate the thoughts of Kundjing in support of his remarks about the similarities between the Pre-Kariara spears and those of the Kariara tribe. They are named:

Fig. 115 'karuparta	Fig. 119 'tjaran
Fig. 116 'karuparta	Fig. 120 'winda
Fig. 117 'karta	Fig. 121 'wadakutara
Fig. 118 'walakuri	Fig. 122 'wadjir

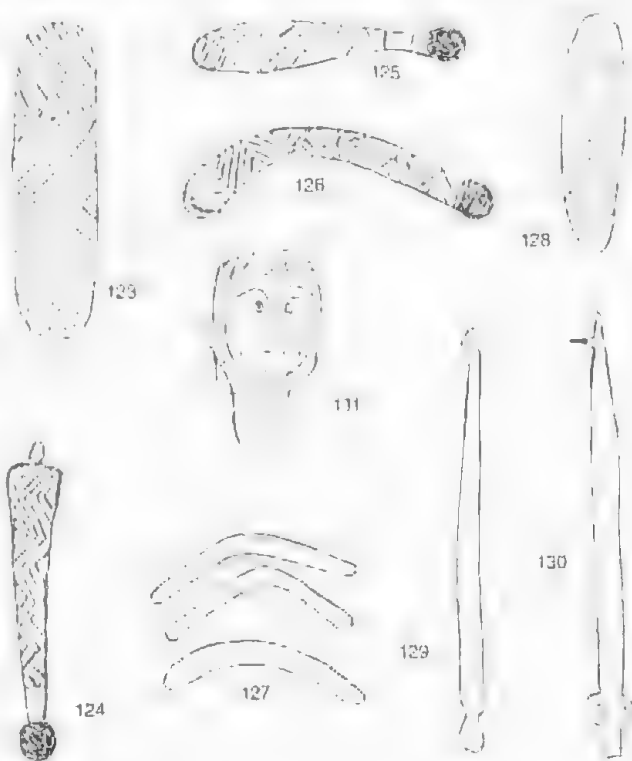
He pictures the harpoon-like spear in Fig. 122 as having a wooden barb integral with the shaft. At first he could not recall its name, *wadjir*. It had a knob at the butt end to help in securing a human hair rope-line, the other end of which was tied about the fisherman's waist. In his drawings the butts of the other weapons were marked, somewhat out of proportion, to indicate that the butts had holes into which spearthrower pegs would fit.

Figures 123-127 were drawn also by Kundjing to illustrate other artifacts of the Kariara, including their *jata* shield, their *walbara* spearthrower, used with the grip between thumb and forefinger (Method A), their club called [*pilbin*], used in close fighting, and in Fig. 126, the *wuruwuru* boomerang for fish killing, which he stressed was cut from the

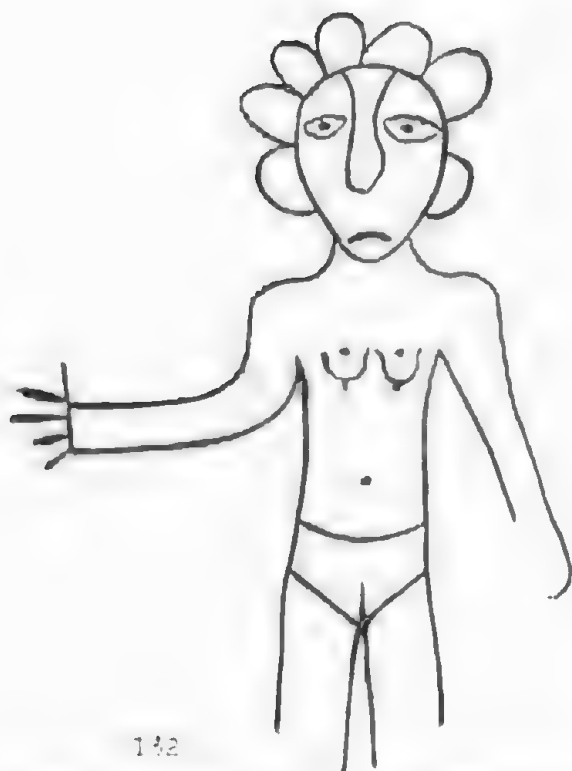
heaviest available hardwood. A group of three boomerangs (Fig. 127) shows the several shapes preferred for their returning ones, the *wakundi*.

Another Aboriginal illustrator, Ngungu, an initiated man of the Pandjima tribe of the Hamersley Ranges, provided two drawings for this paper. His people were leaders in the spreading of the secret rites of initiation for their young men, and according to their traditions, they lived so far to the east in olden days that they had no knowledge of the existence of the sea. Figure 131 gives his impression of a newly initiated [*malbu*] or Pandjima man. Figure 128 pictures their shield, called [*jandijiri*], which shows a very close resemblance to the engraved ones on the rocks at Port Hedland.

Mekata, a member of the Njangamarda Kundal tribe, about 200 km east of the Kariara country, took a leading part in some of our discussions and provided two drawings illustrating long spearthrowers, known as [*ngabalinj*], shown here in Figs 129-130. These are used in the throwing of



FIGURES 123-131. Further illustrations by Aborigines. 123-127, drawn by Kundjing, of Kariara objects; 123, shield, *jata*; 124, spearthrower, *walbara*; 125, club, *pilbin* for close fighting; 126, boomerang for fishing, *wuruwuru*, also used while standing up 'arm in arm'; 127, outlines of three *wakundi* returning boomerangs; 128, shield, *jandijiri* of Pandjima tribe of Hamersley Ranges by man Ngungu; 129-30, long spearthrowers *ngabalinj* traded to Njangamarda tribe through Mangala from Walmadjari people whom they call 'Tjiwaling; they are used with the index and middle finger grip; 131, concept by Ngungu of a newly initiated Pandjima *malbu* or man.



132

FIGURE 132. Strange figure, not recognised by the present-day Kariara — possibly of foreign origin.

spears while employing the grip (my Method B) in which the spearthrower is held between the fore- and middle fingers. These are obtained by trade from the Mangala tribespeople who in turn were said to get them from the Tjiwaling people still further east. Later at Christmas Creek Station we learned that Tjiwaling was a western name for the Walmadjari who were in contact with the Kitja and the Djaru of the Hall Creek area. Thus there were indications of a trade route for *ngabalinj* of about 900 km. This seems to have provided a route by which cultural novelties came to the Kariara.

CONCLUSIONS

There are few direct clues as to the age of the Port Hedland rock carvings. Present-day Kariara Aborigines accept them as being made by people similar to themselves and consider that they understand their meanings and the motives influencing the earlier artists who made them. Kundjing, one of the oldest living Kariara men, recalled a tradition of people like themselves coming from the south and making some of the engravings.

Geologically the situation of the freshly planed off rock surfaces on which the engravings are concentrated, standing as they do only three to four metres above the present highest tide marks of the bay, yields a limiting date falling near the end of the latest Peronian eustatic higher sea level at

around 3 500 to 3 700 BP. The relative absence of signs of aerial erosion tends also to place a further limit on the age of the carvings. The Kariara recognise the principal types of their own weapons as being present among the engravings, and they have ready explanations for the meanings of the designs. The presence of engravings of hafted edge-ground stone axes is important. Mulvaney (1975: 194) concluded that there may have been some reason for a gap between the older Pleistocene stone axes of the tropical parts of Australia and the far younger basaltic rock types which appear so commonly in much of Australia from Mid-Recent time on. In parts of Australia where stingless honey bees occur, the present-day axes are constantly being employed in the chopping out of their nests in the hollows of trees. In the Kimberleys of Western Australia both earlier and later axe types have been found. Mulvaney (1975: 147) shows a photograph of a pecked, grooved, older type axe from Stonewall Creek, and another well-worked one was found by us (Tindale 1981: 1772, Fig. 5, right) at Moolabulla, near Halls Creek, with similar groove on a quartzite core. After some use the Moolabulla one had been adapted by knapping to form a chopping tool of the type considered to be characteristic of Karran times in the earlier half of the Wisconsin or Last Ice Age.

In earlier paragraphs references were made to the *tjimari* knife as present among the engravings at the Port. Figure 133 shows a living culture Njanga-marda example obtained by J. B. Birdsell and P. J. Epling during an early stage of the fieldwork at Marble Bar. It may be considered very characteristic of ones widely known today from the western part of Australia. In some tribes there *tjimari* are still in general use and in others they are kept, in secret, away from women, and used only in their initiation rites for young men. The discoidal form of such flake knives becomes well developed in use and generally as the result of one or more retrimmings. The knapped parts extend around about one-half of the perimeter. After retrimming, some of them are developed with a partly concave margin when needed for trimming such objects as shafts of spears and those of other weapons such as clubs. The back of the knife, covered by the resin handle from the very conception of the flake as a tool is often entirely untrimmed and may be untidily irregular, which may be useful in strengthening the bond between handle and knife. In archaeological specimens this contrast of untrimmed and worked parts leads rather readily to their identification as *tjimari*, as does also the frequent presence of roller-pressure fine-trimming preserved on the cutting edge of the knife (Tindale 1965).

In eastern Australia, particularly in the riverine corridor lying west of the Great Dividing Range,

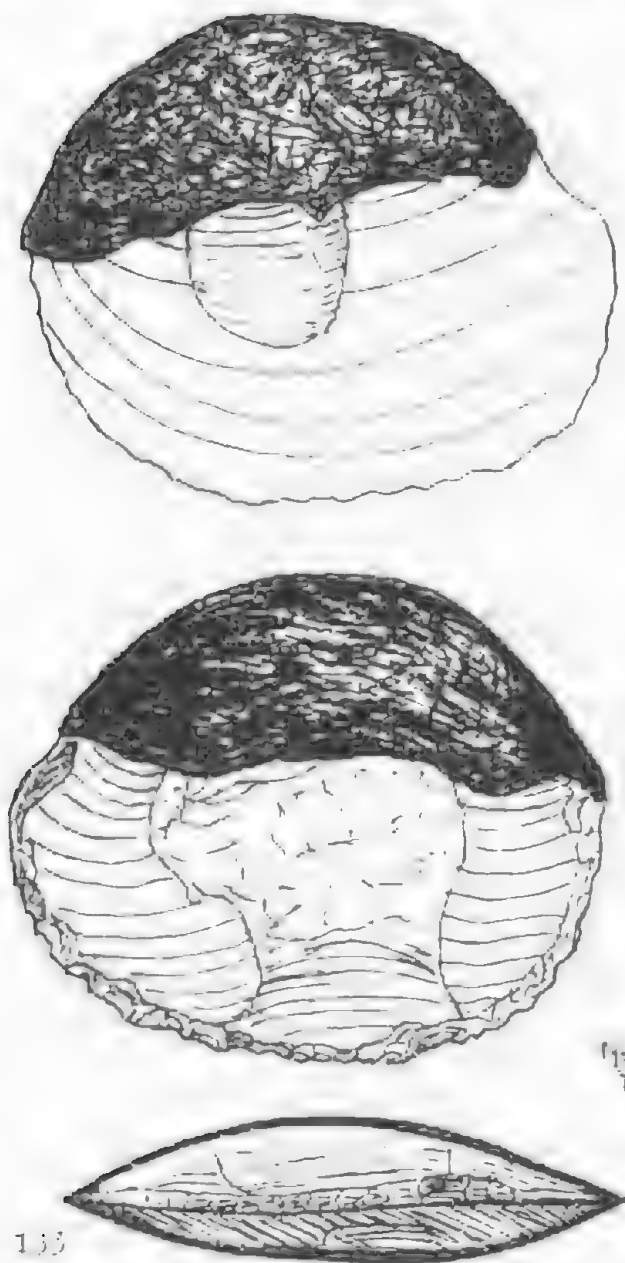


FIGURE 133. Resin-hafted unitacially worked flake knife. *tjimari*, of crypto-crystalline gray chert from Kardama Hill, east of Warrawagine, received from Mudjing of the Njangamarda tribe, May 1953, diameter 7.7 cm.

the use of *tjimari*-like tools was replaced in the Mid-Recent by other tools, ones of the so-called Microlithic Culture Phase which appeared suddenly, full-fledged, and spread widely just after the Mid-Recent, rather quickly in the east and more slowly across the desert interior to the west. Hale & Tindale (1930) found the original evidence for the change-over in mineralised beds at Tartanga, on the Lower Murray River, an Aboriginally-named midstream island bank. Hale & Tindale selected the name to represent a cultural phase older and geologically separate from a great depth of Aboriginal occupational debris, recording three named phases in an

adjoining rock shelter, then known as Devan Downs, but now correctly recognised by its Aboriginal name, Ngautngaut.

At Tartanga the change-over in stone tools is geologically recorded from older and larger flake ones to the newer microliths, which appear only above a water-laid sterile blue-black clay horizon (their F) of relatively great thickness, now known to be the silt layer deposited during the many centuries of the Peronian high sea levels between 6 000 and 3 500 BP. The few tools found in the post-Peronian beds above it matched those found in the three named phases found in the six metre fill of occupational deposit in Ngautngaut rock-shelter. Thus it happened to be that it was the latest phase of the tartangan culture phase that was named. Its tools were shown in detail (Hale and Tindale 1930: 149, Fig. 4) and from the geological section (their Fig. 4), it is clear that the separation from the microlithic tools of the Upper Beds G to I is real and complete. From the beginning it was recognised that the Tartangan type site tools were in an area where stone for tools was not readily available and other richer sites were soon on record in the South East of South Australia and elsewhere. After interest in Australian archaeology developed elsewhere it unfortunately happened that misinterpretation of the Tartangan data as published, led to the ignoring of the clear-cut geological evidence. This seems in part to have been due to an older view that Australian stone implements could not be typed and that all kinds were present only by chance. There was little appreciation of the long time-span of the occupation of Australia. Today it is clear that the Tartangan stone tools can be recognised as dominating the Australian culture scene from as early as the Pleistocene occupational horizons of the 30 000 BP era at Lake Mungo, in New South Wales down to around 6 000 BP in eastern Australia, with survivals of some of its tools in a slowly progressing transitional phase, spreading towards the west and leading to the dominance of the Microlith tool type still in progress in the far west. Thus the presence of the *tjimari* as the key tool of the long-lasting Tartangan phase in Australia and Tasmania and surviving in part even today in the northwest, is important. Very isolated tribes, such as the Nakako, who first came into contact with Europeans only in the 1960s, live more than 900 km south-east of the north-west coast. They also had the same Tartangan-type knife.

Mulvaney, unfortunately, in disregard of the great priority in our nomenclature, has tended to avoid recognising the reality of a Tartangan culture phase and its range of key tools, tending to use instead a vague term such as 'tasmanoid', to describe his own finds at Kenniff Cave and elsewhere. An anthropologist with geological training should re-

examine the site on Tartanga Island. Having had training in Pleistocene geology myself, it is my opinion that the geological realities of the original Tartangan site should be studied again, when the original work there will be cleared of the errors in interpretation which have occurred. The priority and status of the term Tartangan also will be verified.

ACKNOWLEDGMENTS

This author acknowledges the support in his researches by the Members of the Board of the South Australian Museum and its Directors over the more than sixty-five years of his association with the organization.

Permission to do fieldwork was granted by the then Department of Native Welfare of Western Australia to members of the University of California at Los Angeles and the University of Adelaide Anthropological Expedition of 1952 to 1954. Professor Joseph B. Birdsell and this writer (accompanied for several months by the late P. J. Epling) made anthropometric records and conducted anthropological enquiries among the Aborigines of Western Australia.

Members of the Expedition had the full co-operation at all stages of the Native Welfare officers, and for the particular work at Port Hedland District Officer Harvey Tilbrook was most helpful in stimulating the interest of

the Aborigines in the work of the Expedition. In the course of the eleven months spent in Western Australia more than a thousand Aborigines helped in the studies.

Joseph B. Birdsell and I have been associated in such fieldwork since 1938 and I appreciate continuing periodic discussions with him. My wife Muriel Nevin Tindale has been helpful in the ordering of this paper, and Mrs Eloise Hardman has had the onerous task of deciphering my almost impossible writing. I am indebted to Peter Sutton and Christopher Anderson who saw this paper through the press while I was absent in California. There may be some errors of which I am unaware, and some omissions of data still in my extensive field journals; for these I must be held responsible.

ENDNOTES

1. In this paper when individual Aboriginal words and names are mentioned for the first time they are transcribed in International Phonetics as set out in my book on Australian tribes (Tindale 1974: 2) and placed in square brackets. When used again they are given in close conventional form, with place names in particular following the mandates of the Geographic II system of spelling.
2. [miti] is their normal word for blood, not *taraa*.

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OBITUARY IFOR M. THOMAS 1 APRIL 1931 [I.E. 8 JULY 1909] – 14 AUGUST 1985

BY S.J. EDMONDS

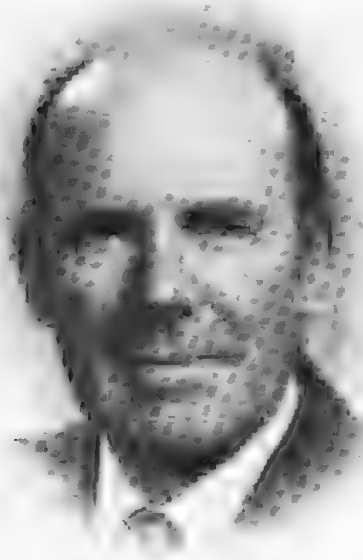
Summary

Ifor Morris Thomas was born on 8 July 1909 at Aberdare, south Wales and died at Adelaide on 14 August 1985. He was the fourth and youngest son of Thomas and Jane Thomas (née Watkins). His father was Headmaster at Aberdare Grammar School. Ifor received his primary and secondary education locally and in 1928 went on to study science at the University of Wales at Cardiff. He graduated B.Sc. in 1931 and B.Sc. (with Honours) in 1932. In 1933 he undertook postgraduate research on crustaceans under Professor Tattersal and at the end of the year gained the degree of M.Sc. After graduation he acted as Demonstrator in Zoology, gave a series of lectures on Biology to the Workers' Educational Association of Wales and, much to his liking, spent some time on board a trawler in the North Atlantic as a collector of marine specimens. His Atlantic experience undoubtedly influenced the future course of his life, serving to stimulate a keen and life-long interest not only in marine biology but also in boats, ships and the lore associated with them.

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He came to Australia in January 1939 to take up a lecturing post in the Department of Zoology at the University of Sydney, at that time under the direction of Professor W. J. Dakin. His arrival happened to coincide with a huge bushfire which endangered many districts along the coast of New South Wales and covered Sydney with a pall of smoke and ashes. He used to relate how dismaying were his first impressions of Australia. He soon

found himself, however, fully occupied in his new post, where his duties included teaching and organising classes in physiology, lecturing on invertebrates and assisting in the running of a small collecting vessel called the 'Thistle'. When World War II broke out in 1939, Ifor and a colleague, Allan Colefax, became involved in devising ways of camouflaging objects at sea and on land. They specialised on the construction and use of different kinds of netting for use in concealing things on the ground.

In 1947 Ifor joined the staff of the Department of Zoology of the University of Adelaide as Lecturer and became Senior Lecturer in 1950. He remained in Adelaide for the rest of his life and occupied a senior post in the Department until he retired at the end of 1974. In 1973 and 1974 he acted as Head of the Department. In 1947 the lecturing staff of the Department consisted only of him and Professor T. H. Johnston. During an association of almost 30 years with the University of Adelaide he lectured to students at all levels and on almost all aspects of zoology. Most of his early teaching was to second and third year classes but as the number of post-graduate students increased and the number of the staff grew, more of his attention was given to those reading for Honours, Masters and Ph.D. degrees. His chief interest was marine zoology. His third year 'unit' course in marine zoology was always a popular one; students found the lectures and practical work interesting and

stimulating. For many years he used to take a party of his students for a couple of weeks each year to the CSIRO Marine Laboratory at Cronulla, New South Wales, where they made good use of facilities that were not available in Adelaide. The trips were a great success and much liked by the students. Some of them, although now old and sere, still talk about them when they meet. Most of his advanced and post-graduate students took for their research topic some aspect of the biology of a common, South Australian marine or freshwater animal. Some of the animals studied were the freshwater mussel, rock lobster (crayfish), whiting, garfish, 'Coorong' mullet and black bream. Consequently his influence in the fields of freshwater and marine research in South Australia was very considerable. Many of his former students today occupy posts, some senior, in the State Fisheries Department, the State Water Laboratory, the South Australian Museum and Australian Universities. Without doubt most of them were encouraged to pursue their careers as marine zoologists or ichthyologists as a result of attending his classes.

His own research was concerned with: (1) the taxonomy and certain aspects of the physiology of enteropneusts (Hemichordata), and (2) the zoology of the intertidal zone. He published papers on both topics. His best paper was probably that on the accumulation of radioactive iodine in the endostylar region of the cephalochordate *Amphioxus*. By using autoradiographic techniques he showed that certain regions of the endostyle of *Amphioxus* were able to take up radioactive iodine to form a mucin-like substance that contained iodine. His results lent support to the idea that the endostyle of the lower chordates was the forerunner or homologue of the thyroid gland of cyclostomate fishes and so of early vertebrates. He wrote two papers on intertidal shore life. He enjoyed nothing more than working along the coast, especially during the summer. On such occasions his 'outfit' was special — a very large, wide-brimmed straw hat (held in position by an elastic chin-strap), slightly 'oversized' shorts, a khaki shirt, long stockings (he sunburnt easily) and white sand shoes. To a collecting bag, held in place by a strap around his shoulder, were fastened by plastic tapes a pair of scissors, a pair of forceps, a hand

lens, a large pocket knife and a pencil. For good measure his spectacles were sometimes attached to the lapel of his shirt. So engrossed was he in his work, however, that he was never aware of the slightly puzzled looks that he sometimes drew from quizzical bystanders.

After retiring from the University at the end of 1974, he continued an active, scientific life as an Honorary Associate attached to the Marine Invertebrates Section of the South Australian Museum. His work was now directed mainly along two lines. Firstly, he acted as advisor to the Electricity Trust of South Australia on the thermal pollution of marine environments caused by the building of power stations in the State. Secondly, he acted as co-editor of one of the recent publications of the Handbooks of the Flora and Fauna of South Australia, namely 'Marine Invertebrates of Southern Australia, Part I'. The book is a very useful one because it helps to fill some of the gaps in the knowledge of the invertebrates of the State. Part II was almost completed when he died.

During his life in Adelaide he took an active interest in a number of societies. He served as Secretary, Librarian, Councillor and President of the Royal Society of South Australia and acted as Assistant Editor of its *Transactions* for a number of years; in 1977 he was made an Honorary Fellow, a rare honour. He was a member of the Royal Zoological Society of South Australia, the Australian Marine Sciences Association, the Nature Conservation Society, and the National Trust of South Australia. He was also a member of the Institute of Biology.

To those who knew him well he was a good friend and a valued colleague. He could be courageous, too. Not many people know that about four years ago, by challenging an apparently armed man, he foiled the robbery of a suburban bank.

If he was well-liked by both his students and those with whom he worked, and was always approachable, reasonable and helpful. His contribution to marine zoology in South Australia was a most valuable one.

He is survived by his wife (née Patricia Mawson) and three sons.

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OBITUARY BRIAN DAILY 1 APRIL 1931 – 6 MARCH 1986

BY S.J. EDMONDS

Summary

Dr Brian Daily died in his home in Adelaide on 6 March 1986, after a courageous battle with cancer, during which he continued to work right up until his death. For five years in the 1950s he had worked in the South Australian Museum.

OBITUARY

BRIAN DAILY

1 April 1931 – 6 March 1986



Dr Brian Daily died in his home in Adelaide on 6 March 1986, after a courageous battle with cancer, during which he continued to work right up until his death. For five years in the 1950s he had worked in the South Australian Museum.

Brian was born in Adelaide on 1 April 1931. Following schooling at the Marist Brothers School, Norwood, and Sacred Heart College, Somerton Park, Brian attended the University of Adelaide where he completed his B.Sc.(Hons.) in 1952 with a thesis on the Tertiary sequence of the Noarlunga Basin. He continued on to his Ph.D. on the Cambrian stratigraphy and palaeontology of South Australia. This work, for which he was awarded the 1956 Tate Medal of the University of Adelaide, has been the basis of most subsequent studies on the Cambrian of South Australia. The faunal assemblages that Brian established have been used as a reference succession for Australian Lower Cambrian sequences.

While still a student in 1954, he joined the late C. P. Mountford's National Geographic Society expedition to Arnhem Land, and made the first comprehensive collections of fossils from Bathurst and Melville Islands. Mostly ammonites, these are still being studied.

Brian completed his Ph.D. late in 1955, and joined the South Australian Museum in January 1956, as Assistant Curator of Fossils. Subsequently he became Curator of Fossils and Minerals, demonstrating his versatility and gaining valuable experience for his later career. Brian was indefatigable in the field, as many of his students can attest. While at the Museum, he collected widely throughout the State: Tertiary plant fossils on the Arcoona plateau in 1956 and again in 1960; Pleistocene mammals at Hookina Creek in 1956; Cambrian trilobites from Kangaroo Island in 1957, and Precambrian fossils at Ediacara in 1957, 1958 and 1959. He also collected from the Cambrian and Triassic

of the Flinders Ranges in 1959, and from the Cambrian and Ordovician of central Australia in 1959 and 1960.

In 1957, Brian joined Professor R. A. Sturton of the University of California, Berkeley, for a three month expedition into the Lake Eyre region in search of Tertiary marsupials at Lake Palankarina and adjoining areas, discovering the richly fossiliferous deposit of Pliocene Manipuwordu Sands in the Lawson-Daily quarry, and making an important contribution to the understanding of the geology of the area. His interest in the region continued through the years, and he and his students used the southern shores of Lake Eyre North for fieldwork.

During these years, he began to take on a consultancy role, examining bore material for the South Australian Mines Department and petroleum explorers. Thus he studied the fossils of the Minlaton and Stansbury Stratigraphic Bores on Yorke Peninsula, and later, the Gidgealpa No. 1 Well.

With several fellow students, he had been a founding member of the Cave Exploration Group of South Australia in 1955, and was influential in having that society closely affiliated with the South Australian Museum so that all specimens encountered, both fossil and living, became part of the State collections. Thus he was involved in a number of excavations in Naracoorte caves in 1957 and 1959, mainly for the (then) puzzling *Thylacoleo* or marsupial 'lion'. This interest in vertebrate fossils was maintained despite his first love — the Cambrian — and communicated itself subsequently to a number of his students, including one of us (NSP).

Brian resigned from the South Australian Museum in January 1961, and was subsequently made an Honorary Associate of the Palaeontology Section. He was appointed a Lecturer in the Department of Geology and Mineralogy, University of Adelaide, in 1961; was promoted to Senior Lecturer in 1964 and to Reader in 1974, a position he held until his death. Brian was an enthusiastic and dedicated teacher, particularly of field work. He was an excellent field observer with a wide general geological knowledge which he passed on to his students. During his time at Adelaide University, Brian supervised more Honours Degree projects than any other person in the department and also supervised a number of successful M.Sc. and Ph.D. projects, mainly on the Adelaidean and Cambrian geology and biostratigraphy of the Flinders Ranges.

Brian's main research activities were on the Precambrian and Cambrian stratigraphy and sedimentology of South Australia. He made substantial contributions to the study and understanding of the Precambrian/Cambrian boundary, both in Australia and overseas. This work included visiting important Precambrian-Cambrian boundary sections in North America, Argentina, China,

Morocco, Europe and Siberia. He was a valuable member of J.G.C.P. project 7, 'South-West Pacific Basement Correlations', the results of which were published in G.S.A. Special Publication No. 9. In elucidating the stratigraphy and structure of the Kanmantou Group, Brian, in association with Dr A. R. Milnes, made a major contribution to the understanding of the geology of Fleurieu Peninsula and Kangaroo Island. Unfortunately much of Brian's detailed and pioneering work on the Adelaidean and Cambrian sequences of the Flinders Ranges was unpublished at the time of his death.

In addition to his professional duties, Brian gave much voluntary service both to geology and science in general. In the period 1957-67 he was successively programme secretary, council member, vice-president and president of the Royal Society of South Australia. He was chairman of the S.A. Division of ANZAAS in 1981-1983 and was the ANZAAS correspondent for some years. His interest in geological education is shown by his acting as chairman of the S.A. Public Examination Board Geology subject committee and also a chief examiner of matriculation geology in South Australia over a number of years. Brian was a member of the S.A. Divisional Committee of the Geological Society of Australia in 1965-66, vice-chairman in 1967-68 and chairman in 1968-69 and was a proxy member of the federal executive of the G.S.A. in 1980-81. He served on both the S.A. Stratigraphic Nomenclature and Geological Monuments Subcommittees.

Both as a friend and a colleague Brian will be sorely missed. Deepest sympathies are extended to his family.

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INLAND, COAST AND ISLANDS : TRADITIONAL ABORIGINAL SOCIETY AND MATERIAL CULTURE IN A REGION OF THE SOUTHERN GULF OF CARPENTARIA

BY D. S. TRIGGER

Summary

This paper compares aspects of traditional Australian Aboriginal societies in inland, coastal and island settings, in a region of the southern Gulf of Carpentaria. It focuses on similarities and differences in material culture after summarising comparative data on language, emic environmental classification, kinship and social organization, and genetics. As 'saltwater people' occupying what was regarded as 'saltwater country', coastal mainlanders were part of the island cultural bloc in significant respects, while being in other respects incorporated within a large cultural bloc which extended inland to the west and southwest. The paper proposes that the coastal mainlanders' relationship with the North Wellesley Islanders in particular, reinforced the maintenance of cultural differences between coast and inland society on the mainland. Despite arguments for the relative isolation of the South Wellesley Islanders, the paper describes a complex situation of overlapping cultural forms throughout the region, with no area emerging as completely distinctive.

INLAND, COAST AND ISLANDS: TRADITIONAL ABORIGINAL SOCIETY AND MATERIAL CULTURE IN A REGION OF THE SOUTHERN GULF OF CARPENTARIA

D. S. TRIGGER

TRIGGER, D. S. 1987. Inland, coast and islands: traditional Aboriginal society and material culture in a region of the southern Gulf of Carpentaria. *Rec. S. Aust. Mus.* 21(2): 69-84.

This paper compares aspects of traditional Australian Aboriginal societies in inland, coastal and island settings, in a region of the southern Gulf of Carpentaria. It focuses on similarities and differences in material culture, after summarising comparative data on language, emic environmental classification, kinship and social organization, and genetics. As 'saltwater people' occupying what was regarded as 'saltwater country', coastal mainlanders were part of the island cultural bloc in significant respects, while being in other respects incorporated within a large cultural bloc which extended inland to the west and southwest. The paper proposes that the coastal mainlanders' relationship with the North Wellesley Islanders in particular, reinforced the maintenance of cultural differences between coast and inland society on the mainland. Despite arguments for the relative isolation of the South Wellesley Islanders, the paper describes a complex situation of overlapping cultural forms throughout the region, with no area emerging as completely distinctive.

D. S. Trigger, Department of Anthropology, University of Western Australia, Nedlands, Western Australia 6009. Manuscript received 10 August 1986.

This paper presents comparative ethnographic data in a reconstruction of aspects of cultural diversity among Australian Aboriginal societies in an area of the southern Gulf of Carpentaria (Fig. 1). It is concerned particularly with the situation of coastal mainland dwellers located adjacent to two major off-shore island populations, and apparently subject to influences from diverse cultural traditions. These are traditions which will be glossed as those of 'inland society' on the one hand and 'islands society' on the other hand, although both labels themselves encompass a degree of cultural diversity.

The paper investigates the ways in which a mainland coastal group's relations with off-shore island societies may have influenced the former's relations with other mainland societies (particularly inland ones). It will be argued that while the coastal mainland society can be seen in some ways to be included within a broad cultural bloc extending inland to the west and south-west, in other respects it is clearly on the periphery of that bloc. The paper proposes that the influence of ongoing relations with North Wellesley Islands societies can be seen as having kept coastal mainland society on the periphery of the cultural bloc extending inland to the west and south-west. Hence, rather than focusing directly on the degree of isolation of the islands society, my approach is to ask whether major off-shore islands society exercises important influences over immediately adjacent mainlanders, thereby reinforcing tendencies towards cultural differences between the latter and those further inland.

Cultural differences between coast and inland in the Gulf of Carpentaria context have been noted in previous literature. Spencer & Gillen (1904: 634) mention the 'very considerable uniformity' in material culture in inland areas on the southwest side of the Gulf, 'until we come to the true coastal tribes, amongst whom we naturally meet with certain objects not present amongst the inland tribes'. For the south-eastern side of the Gulf, Tindale (1974: 121-122) notes the 'great contrasts between the life and economies of the inhabitants of the coastal mangrove and saline shore flats and the ways of the scrub covered upland dwellers'. Tindale also refers to the Aboriginal terms given in Curr (1886: 303) for the Leichhardt River mouth area, designating distinctive peoples of saltwater, freshwater and scrubland domains. Detailed material for the Cape Keerweer area on the east side of the Gulf, has been given in Chase & Sutton (1981). Those people living along the coastal strip are described as not having interacted closely with hinterlanders. Their territories are much smaller than those of inlanders with correspondingly higher population densities. Coastal people also possessed higher social segmentation, a richer ritual tradition and greater linguistic diversity (Chase & Sutton, 1981: 1835).

A considerable amount of literature is available for the study region dealt with in this paper. This is especially the case for work on the cultural traditions of the Wellesley Islands. Together with the results of my own research, this literature provides a sound basis for a broad comparative study of Aboriginal society in different environ-

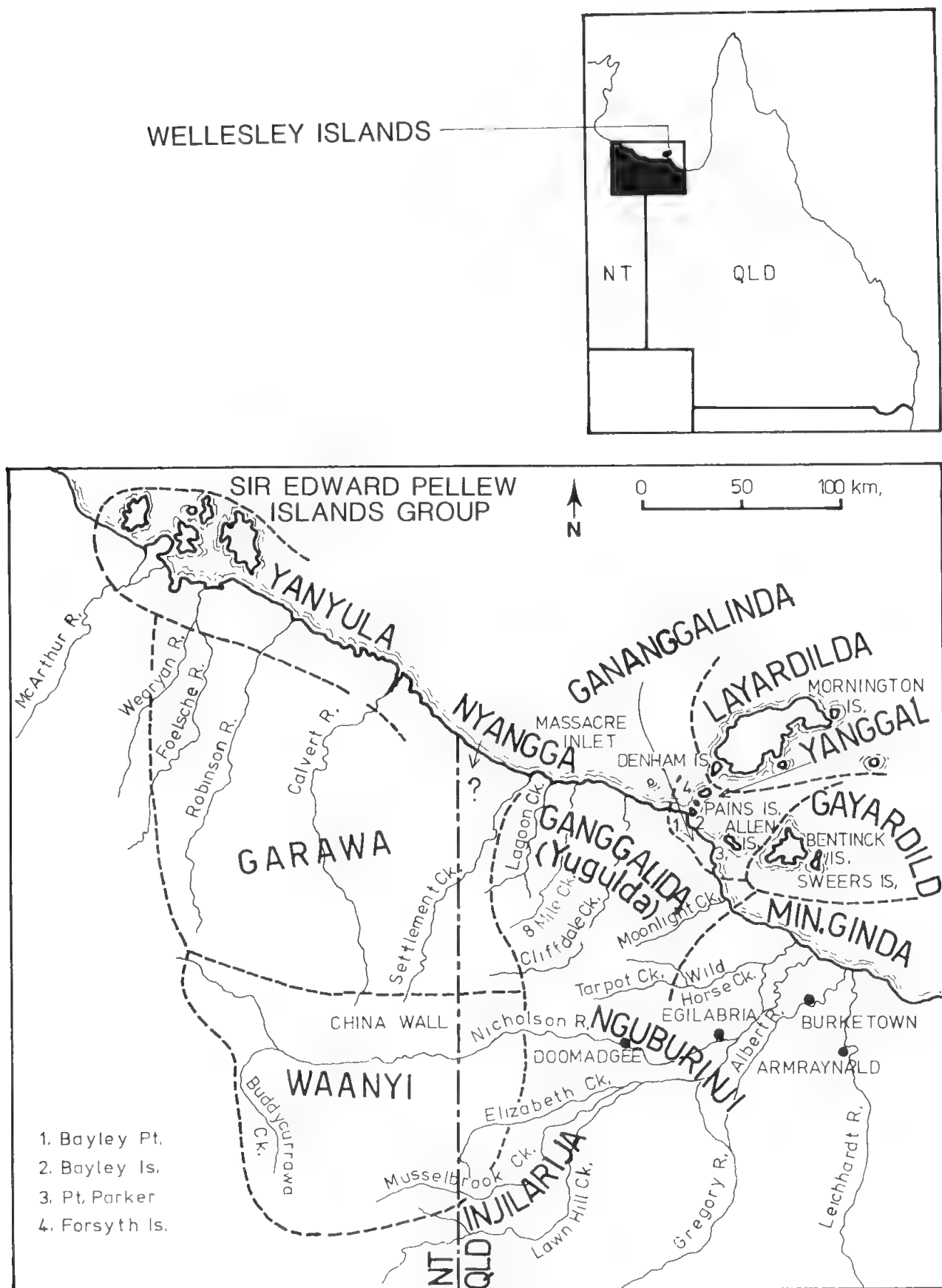


FIGURE 1. Linguistic territories from Aboriginal perspective during the study period.

ments. While other publications are planned, the present paper focuses mainly on a comparison of aspects of material culture across inland, coastal and island settings. Several museum collections of material culture from the region have proved a valuable resource in reconstructing aspects of traditional life. However, to establish the broader context for the data on material culture, I will first briefly discuss several more general issues: (1) the linguistic setting; (2) emic environmental classifications; (3) kinship and social organisation; and (4) genetic similarities and differences through the region.

THE LINGUISTIC SETTING

This paper primarily concerns four definable areas within the range of language groups shown in Fig. 1: Garawa and Waanyi in the inland area to the west and south-west of the Wellesley Islands; Ganggalida¹ (and Gananggalinda) on the coast adjacent to the islands; Layardilda² and Yanggaal on Mornington, Denham and Forsyth Islands (constituting the main islands of the North Wellesley group); Gayardild on Bentinck and Sweers Islands (constituting the main islands of the South Wellesley group). Several points concerning the linguistic territories of the region warrant brief comment.

Contemporary Aboriginal opinion makes it clear that 'Garawa people'³ were not 'saltwater people'. Mapping of traditional Garawa estates which I have completed indicates the northern most of them to be no closer than 25 km from the coast (cf. Tindale's [1974: 228] figure of 65 km). Across most of the northern limit of Garawa territory, the coastal area is Yanyula country. However, it remains unclear which language group was predominant in the coastal area eastwards from the Calvert River to the west side of Massacre Inlet (the western boundary of coastal Ganggalida country). The language name 'Nyangga' has been applied to this area in the literature, and I have discussed elsewhere (Trigger 1985: 340-349) whether there was in fact such a distinctive group in dialectal, territorial or sociopolitical terms. The issue is raised here to note that in comparing aspects of the inland Garawa traditions with the coastal Ganggalida traditions, I am most likely not comparing territorially adjacent linguistic groups.

We should also note the question of territorial proximity between Waanyi and Ganggalida traditions. As far as I have been able to reconstruct them (Trigger 1982, Map 11), traditional Waanyi estates extended eastwards at least 30 km into Queensland from the Northern Territory border. The most precise data concern an eastern-most Waanyi estate on the Nicholson River. This does

not indicate close proximity between Waanyi and Ganggalida as it is doubtful whether Ganggalida speakers were predominant along the Nicholson River in Queensland; the minimal but most reliable information (a hand-written note on a word list by Roth [1900]) suggests that Nguburinji speakers were predominant in this area (cf. Keen 1983: 193).

Linguistic work indicates that Nguburinji was mutually intelligible with Ganggalida, and in fact that these two, together with Yanggaal (on Forsyth Island) and Gayardild (on Bentinck Island), were dialects of one language; Layardilda (on Mornington Island) was 'a different but closely related language' (Keen 1983: 192; and see Evans 1985: 3). Two further points are thus significant. Firstly, the nature of linguistic relations demonstrates the incorporation of two substantial linguistic territories on the mainland (Ganggalida on the coast and Nguburinji further inland) within the 'Tangkic sub-group' (Evans 1985) extending throughout the Wellesley Islands. I use the notion of 'incorporation' of the islands and a section of the mainland deliberately to emphasise the lack of linguistic isolation of the island societies; Tindale's discussion of 'the relative isolation' (1962a: 278; and see also 1977: 256-7) of the language of the Bentinck Islanders is clearly inadequate (cf. Evans 1985: 9).⁴ Secondly, Ganggalida speakers quite likely extended inland from the coast for a considerable distance (possibly up to 100 km); however, in the comparative analysis presented in this paper it is aspects of *coastal* Ganggalida society which constitute the significant unit.

The final point in discussing linguistic aspects of the region concerns the area on Fig. 1 labelled 'Gananggalinda'. This term was known during my research by only a few senior Ganggalida people. It was applied to a group of people said to have 'belonged beach side' in the area between Bayley Point and Point Parker (i.e. the coastal mainland area *immediately* opposite both the North and South Wellesley Islands, and incorporating a distance along the coastline of approximately 20 km). These are people said to have routinely visited several small islands comparatively close to the mainland (namely Bayley and Pains Islands approximately 3 km and 4.5 km off Bayley Point respectively, and Allen Island approximately 5.5 km off Point Parker). One senior knowledgeable Ganggalida woman has defined Gananggalinda as a form of speech very similar to Ganggalida, but with a different accent. However, it is probable that the term was essentially applied to a group of people rather than to a dialect.⁵

In establishing the setting for the further comparisons in this paper, it is appropriate to recognise these Gananggalinda people as a mainland group which was regarded by fellow

coastal mainlanders (at least those to the west) as *particularly* closely oriented towards the immediately adjacent small islands to the north and east. Indeed, it is probable that these people spent substantial time on the close off-shore islands, in regular contact with Yanggaal speakers based on Forsyth Island. They also had occasional contact with Layardilda people from Mornington Island, and perhaps even sporadic contact with Bentinck Islanders who may have travelled across to Allen Island. The latter contact would have involved safely traversing a distance of approximately 13 km by watercraft, and Tindale (1962b: 298–301) gives accounts of two attempts (in 1940 and late 1946 or early 1947, prior to major intervention by Europeans) where lives were lost. In the second attempt, 14 out of 19 persons attempting the crossing were drowned, and there is little doubt that such trips would not have been undertaken without knowledge of the great danger. Yet, it is likely that the factors reportedly leading to the 1940s crossing attempts (particularly quarrels and fights), among others, would have, in earlier days, led to sporadic successful crossings by small numbers of people from Bentinck Island to Allen Island. Tindale (1962a: 273, 290–291) found oral traditions among the Gayardild which recounted occasional hostile encounters with mainland Aborigines on Allen Island. Evans (1985: 15–16) suggests that 'whatever contacts there were, that did not end in death or exile, must have been separated by decades of isolation'; he also mentions that nothing was obtained by the Bentinck Islanders via trade.

Having mentioned this distinctive 'beach side' mainland group, I will nevertheless subsume them within the category of coastal Ganggalida people throughout the paper. In fact, there is little remaining specific knowledge of these people, and among the reasons for this is an apparent revenge killing carried out on Bayley Island by Yanyula people from the northwest. Historical records (*The Queenslander* 10 April 1897: 774) indicate that this

occurred in 1897, and according to Aboriginal oral tradition a large number of people were killed (see Trigger 1985: 140–141).

THE DISTINCTIVENESS OF THE MAINLAND COASTAL AREA: THE ABORIGINAL VIEW

Various kinds of distinctive environments throughout the entire study region are distinguished in Aboriginal classification (Trigger 1985: 63). However, none are regarded as so significantly different as 'saltwater country'. Ganggalida terminology for the coastal area is shown in Table 1. As the English translations indicate, the environment consists of long sand ridges (supporting open woodland) typically parallel to the beach and dune areas. These raised ridges are separated by flat sandy stretches of ground varying considerably in width. In some areas, 'salt pans' or saline coastal flats separate the sand ridges, but the widest area of salt pan is usually between the most inland sand ridge and the beginning of sharply defined open sclerophyll woodland which extends inland to the south (Fig. 2).

From the Ganggalida perspective the sand ridges are termed 'islands' (*murndamurra*). The same term is used for the small islands immediately off-shore. In the Aboriginal view, the 'land' or 'mainland' (*wambalda*) thus begins at the inland limit of the salt pan, which also marks the inland limit of what is generally known as 'saltwater country'. Figure 3 shows this limit approximately, designating a coastal strip of 'saltwater country' extending southwards for varying distances between 3 km and 10 km from the beach. At times during the wet season, much of the salt pan areas are said to be covered with water (probably from tidal surges as well as from the flow of fresh water from the inland), leaving the 'island' sand ridges isolated with water on all sides.

In the Aboriginal view then, the coastal strip is regarded as environmentally distinctive and different from further inland, and in fact is

TABLE 1. Schematic representation of Ganggalida classification of environmental zones in the mainland coastal area.

←----- North					
<i>malara</i> 'sea'	<i>/mirlaja/mala/lilu</i> 'go back/sea/north'	<i>ngarnda</i> 'beach'	<i>dumuwa</i> ... 'sand 'sand ... ridge' ridge'	<i>gabara</i> 'saltpan'	<i>gin.gara</i> 'flat country'
[inter-tidal zone]			... [multiple ridges] ...		[on other side of saltpan]
<div style="text-align: center;"> area containing ←----- <i>murndamurra</i> -----> 'islands' </div>					
←----- 'saltwater country' ----->					'mainland' 'land' <i>wambalda</i>

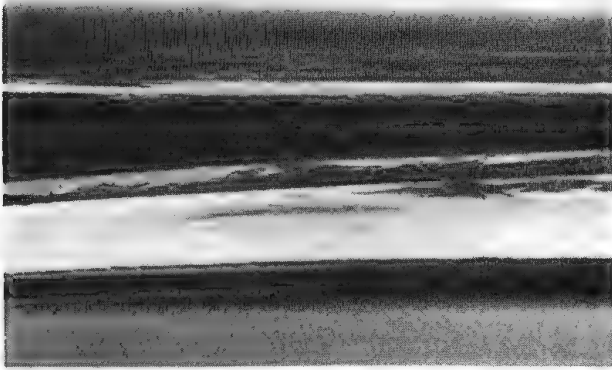


FIGURE 2. The physical environment in the coastal mainland area (Ganggalida country). The long sand ridges parallel to the coast-line are evident from the lines of vegetation. The area of saltpan in the background separates the coastal strip containing 'islands' ('saltwater country') from the 'mainland', in the Aboriginal perspective. The saltpan and mangroves in the foreground occur only occasionally along this stretch of coastline. (Courtesy of Connah/Jones Aerial Archaeology, University of New England.)

conceived (in general terms at least) as containing areas equivalent to the close off-shore islands.⁶ However, this narrow coastal strip should not be considered as socially isolated in any way. Figure 3

indicates quite precise boundaries for the coastal estates, to the east and west; the boundaries are hence the sea to the north, and creeks and salt-arms to the east and west. But the boundedness to the south (i.e. in an inland direction) is much less precisely defined. All estates except one in the area shown on Fig. 3 extend across the saltpan to the 'mainland' to include one or more fresh waterholes. In the case of the exceptional estate (F), it includes site F1 (Gunamula), a large fresh water lagoon near the mouth of Cliffdale Creek, which is said to contain surface water for a substantial part of the dry season. Seasonal movements across the saltpan to waterholes, occurred particularly during the middle and late stages of the dry season, not so much because of a lack of fresh water in 'saltwater country' (for this is said to have been always available by digging 'soaks'), but in order to obtain certain material resources apparently not at that time readily available on the 'islands' (e.g. water lilies, *Nymphaea* sp. and *Nymphoides* sp.). During parts of the dry season people are also said to have come to the coastal strip from a considerable distance inland; however, they apparently rarely remained there during the wet season because of their lack of tolerance of the increased number of mosquitoes then. The significant point here is that apart from the recognition of the environmental distinctiveness of 'saltwater country', people are said

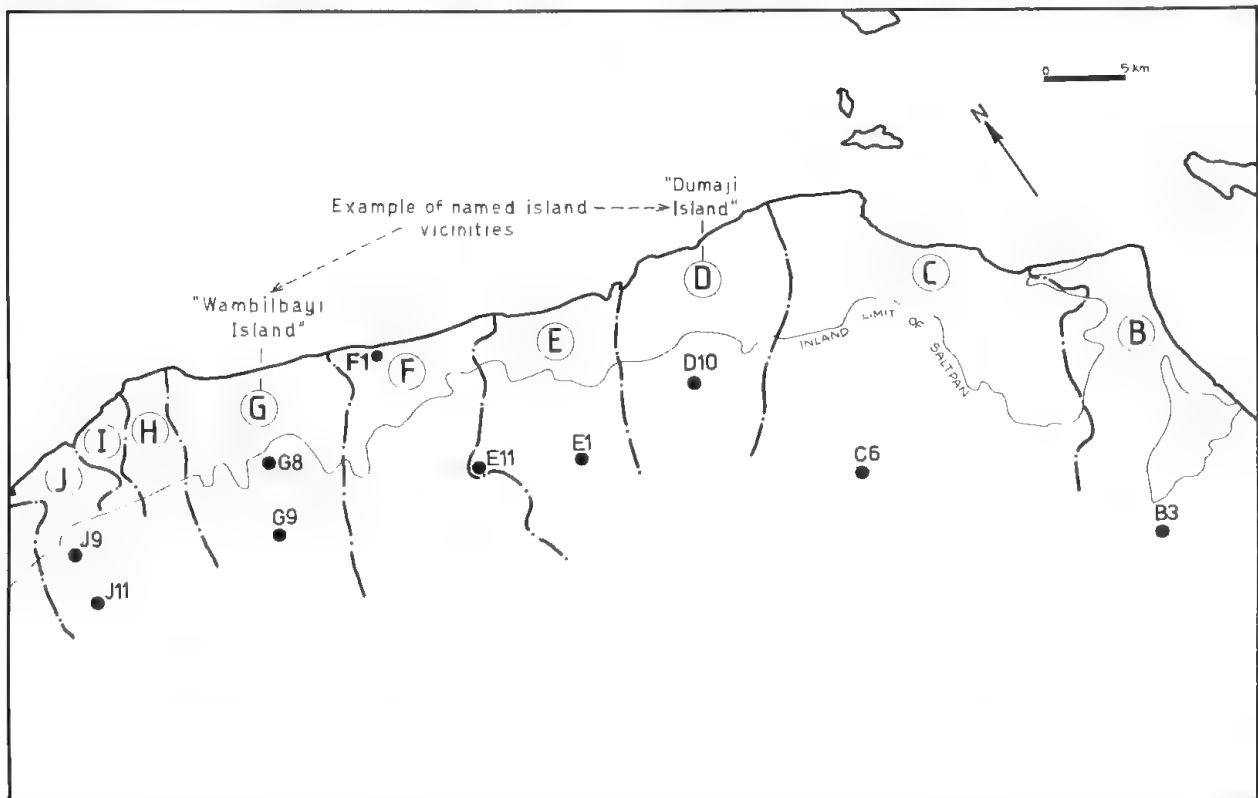


FIGURE 3. Ganggalida and Gananggalinda coastal estates showing the Aboriginal designation of the inland limit of the saltpan areas as the beginning of the 'mainland' (*wambalda*). Certain fresh water holes on the 'mainland' are shown for each estate.

to have moved in and out of it constantly. Nevertheless, it was viewed as the distinctive domain appropriate to a conceptually separable group of 'saltwater people'.

KINSHIP AND SOCIAL ORGANISATION

An Aranda type kinship system appears to have operated traditionally throughout the study region. See Trigger (1985) for some discussion of its nature, and also comments by Warner (1933: 68), Sharp (1935: 160-161) and Hale (1982). Evans (1985: 17-18, 481-492) elaborates the Gayardild system of Bentinck Island and it is clearly of the same type as both others throughout the Wellesley Islands and also as Ganggalida, Garawa and Waanyi on the mainland; Tindale's failure to consider the issue of this similarity (1977: 258-260) again renders his general suggestions about the lengthy isolation of the Bentinck Islanders inadequate. Evans (1985: 21-22) in fact suggests 'a relatively short period of isolation' of the Gayardild (500 to 1000 years), based partly on this matter of kinship system similarity.

However, Tindale (1977: 258-259) does refer correctly to the marked lack of any system of named social categories (or 'class' system as he puts it) on Bentinck Island in comparison with elsewhere throughout the region, though his expression of this fact is at best imprecise in implying that the surrounding groups had 'sections'. Evans' expression of the comparison also lacks precision in suggesting that the Mornington Islanders and those on the adjacent mainland had moieties and sections (Evans 1985: 17). What has operated throughout the region, except on Bentinck Island, is a system of named subsections (Trigger 1985: 69-71, 350-351), though this system can be said to be 'organized as unnamed patrilineal semi-moieties and moieties' (Sharp 1935: 159; 1939: 455).

Putting aside the distinctiveness of the Bentinck Islanders in this respect, and without discussing social organisation in detail here, we may simply note the situation of the coastal mainlanders (Ganggalida). They were included within the mainland bloc stretching to the southwest in having both male and female subsection terms, and were only partly similar to the inhabitants of the North Wellesley Islands in that the latter had male subsection terms only (Sharp 1935: 162, fn. 4). They lacked the named semi-moiety terms which operated within at least the western parts of Garawa country (Sharp 1935, 1939; Reay 1962; Trigger 1987a).

The coastal Ganggalida also apparently lacked the institutionalised role distinction of 'ownership' and 'managership' in relation to land and ritual property, which operated to the southwest (Trigger 1985: Table 6). Although it is difficult to reconstruct their pre-contact ceremonial life because of more

recent influences from the west, it is most likely that the coastal Ganggalida also lacked the major cult ceremonies in which the ownership/managership distinction is so important. In these respects, they were identical to the inhabitants of all the Wellesley Islands.

GENETIC EVIDENCE

Several publications have described similarities and differences of a generic nature between North Wellesley Islanders, South Wellesley Islanders and mainlanders. Among other findings, Simmons *et al.* (1962) discuss the unusually high B blood group gene frequencies among the Bentinck Islanders, as compared with groups in the North Wellesley Islands. However, in later work, Simmons *et al.* (1964) did further comparisons with nearby mainlanders and concluded that the 'Karawa' also had a high frequency of this gene, and in fact have been 'a main source in the spread of the B gene in the mainland tribes of this remote area' (p. 68).

This discussion about certain genetic features of the Garawa people is not without methodological problems.⁷ However, the relevant point to be considered here concerns claims based on this genetic evidence by Tindale (1977: 254-255). He asserts that the 'Karawa' constituted a 'small separate and isolated tribal enclave', and lived in a 'perhaps refuge area'. These assertions fit with Tindale's suggestion that the 'Karawa', like the Bentinck Islanders (and one other very distant north Queensland group) with whom they apparently share certain blood type characteristics, are 'relicts' of a previously more widespread population with this blood-type. Elsewhere, Tindale (1974: 122) himself notes that his speculation that the name 'Karawa' can be translated as 'uplanders' or 'hills people', is 'hazardous'. This is also the case for his other speculations about this group. Neither the sociocultural evidence nor the mapped distribution of Garawa estates in my data, support the suggestion that Garawa people have been in any way isolated, although oral tradition must be regarded as not necessarily providing precise information for historical periods greater than perhaps four generations. Reay's (1962: 95) comments about there 'always' having been 'a great deal of contact, including inter-marriage, between Garawa and Anyula [Yanyula]', are similarly based on ethnographic data. However, inter-marriage between these two language groups has also been indicated in genetic studies carried out by White (1978: 42; 1979: 439, 445).

To summarise the discussion so far, the coastal mainlanders have been shown to be part of a linguistic sub-group extending throughout the Wellesley Islands, and inland for a substantial distance (at least 100 km southwards to the

Nicholson River). To the west and south-west, neither Garawa nor Waanyi (nor Yanyula on the coast) are within this linguistic sub-group. A narrow coastal strip adjacent to the Wellesley Islands is classified in the Aboriginal view as containing areas which are environmentally similar to close off-shore islands, and is conceived as the separate domain appropriate to 'saltwater people'. Nevertheless, substantial movement occurred between coast and adjacent inland, as well as between the coast and the North Wellesley Islands. The fact that the Gayardild in the South Wellesley Islands shared language and kinship system with others on the mainland and in the North Wellesley Islands, means that it is problematic just how isolated these particular islands were. The same type of kinship system extends throughout the study region, however there are differences in the presence of systems of named social categories. Finally, published genetic data assert various differences and similarities between populations in the study region. While there has been a suggestion that the Gayardild (Bentinck Islanders) and the Garawa may be 'relict' groups of a previously more widespread population, ethnographic and certain genetic data indicate a lack of isolation of the Garawa.

Thus, my evidence certainly does not indicate any simple pattern of relationships between the various groups and cultural forms treated so far. We are confronted with a complex pattern of overlapping cultural forms extending throughout inland, coastal and island societies. The paper now turns to a detailed consideration of some aspects of material culture. The evidence here indicates major differences between coastal mainland and the inland Garawa/Waanyi traditions. In a number of respects, the coastal mainland traditions resemble those of the off-shore islands (particularly the North Wellesley Islands), in their differences from Garawa and Waanyi traditions.

DIVERSITY IN INLAND, COASTAL AND ISLANDS MATERIAL CULTURE

In this section I discuss a form of decorative marking, the use of (and attribution of meaning to) shell material, spearthrowers, spears, fishing artefacts and technology, and watercraft.

Decorative marking

The marking known as *jinangglyari* in Garawa/Waanyi is said to be absent from items traditionally produced in 'saltwater country', including both the mainland coastal area and the off-shore Wellesley Islands. The marking is a longitudinal fluted pattern made by an end of the adze-type tool known as *biynmala*. This tool consists of a gently curved stick of varying length with stone blades attached at both ends. One end is typically said to be a broad blade

(known as *gubija*), while the more pointed blade is known as *jinangyi*, hence the name given to the mark it makes.

Roth (1904: 20) refers to this tool as a 'native gouge'. He presents figures showing it and the manner of its use (1904: Plate XIV, Figs 101, 105), and notes 'the Lawn Hill [Station] name' as '*gubija*'. He does not, however, distinguish between the two ends of the implement; although the figure he gives elsewhere (1897, Plate XII, Fig. 235) for areas to the south of the study region, possibly indicates the blade at one end as broader than the other. In dealing with this implement for areas to the west of the study region, Spencer & Gillen (1904: 636–640) describe considerable variation in the size and shape of the attached stone flakes, and discuss the consequent different sizes of fluting made by the implement. Contemporary Garawa and Waanyi older people explain that the *jinangglyari* mark was commonly applied to the convex side of two kinds of boomerangs: *juguli*, near-symmetrical shaped for hunting (QM QE621⁸), and *man.guburana*, hook-shaped for fighting (QM QE4274). The marking was also applied to wooden coolamons, *jugiya* (QM QE51), and sometimes to other items such as spears, clubs and shields (Fig. 4). It is said to have helped ensure that a weapon would 'fly straight', particularly when combined with the right song (cf. Roth's [1897: 146] comment concerning spears).

From the inland perspective, the mark described above distinguished the item as belonging to the network of language groups stretching to the west from, and including, Garawa and Waanyi country; although it is clear from Roth's account, that it was



FIGURE 4. Three items showing the longitudinal fluting mark known as *jinangglyari*, which is absent from items both on the coastal mainland and the Wellesley Islands. (Courtesy Queensland Museum.)

also used in areas well to the south of the study region (see also Mulvaney's [1976: 81] summary map showing its distribution to the south and west of the study region). Items with this mark may have been traded to the coastal 'saltwater country' (and to the North Wellesley Islands) but the mark was apparently not used by coastal artisans. Nor is it likely that coastal people commonly used the tool which made the mark. It is absent from Memmott's (1979a) list of the Mornington Island artefact repertoire. Memmott (1979a: 111) does state the contemporary claim by some 'Lardil' people that the practice of inscribing fluting on hooked boomerangs 'was obtained from the mainland in recent history', and coastal mainlanders may also have partially incorporated the marking during post-contact times. Memmott (1979a: 113) also notes the wooden coolamon as of possible recent mainland origin, and like the 'Lardil', coastal Ganggalida people appear to have only made coolamons from *Melaleuca* bark (Roth's 'pleat-type' [1904: 30]), in pre-contact times.⁹ The adze tool which was absent from the islands and the coastal mainland repertoires, was the implement typically used in inland areas to gouge out wooden coolamons, as well as to inscribe the fluted mark on them.

Shell material

Shell material is of course plentiful in the coastal environment, and the fourteen Ganggalida classifications that I have recorded represent only a portion of such knowledge. By contrast, the inland perspective appears to regard 'saltwater shell' as belonging to two broad size categories only: *rabunya* — 'big one' and *malduwa* — 'small one'. An example of the former is the large 'bailer shell' (*Melo Amphora*) used for carrying water (eg QM QE593, obtained from Allen Island). Roth (1904: 29) notes that on the Wellesley Islands 'the ventral surface of the last whorl of the . . . shell is pierced for insertion of the thumb during transport'. Garawa and Waanyi people are said to have not customarily used this item. Inlanders know that coastal people used both *malduwa* and *rabunya* saltwater shells to construct small and larger (respectively) cutting and scraping implements, and this is seen as having been necessary and appropriate due to their lack of suitable stone material. Freshwater mussel shell was apparently used similarly, but only to a limited extent, in the inland areas. Shellfish also formed a more substantial part of the coastal diet, as compared with the inland diet.

However, the difference in use of shell material that inland people today remark upon, is the coastal people's lack of shell pendants known by inlanders

as *jaramara* (QM QE1809, obtained from the Lawn Hill-Nicholson River area in 1900). This item is pearl-shell (*Pinctada maxima*), as are the others in several museum collections identified by an inland man as *jaramara*.¹⁰ These pearl-shell pendants were received by Garawa and Waanyi people from areas to the west and were considered items of great significance. Their general importance appears to have been as a marker of certain formal social roles. For example, two individuals 'promised' to each other as marriage partners wore *jaramara* (for a short time at least) on the occasion of the promise being formally and ritually recognised. A further example is a woman wearing the item following her child's death, particularly in any associated ritual settings. The *jaramara* thus marks its wearer as the focus of ritual related to an important social situation. Occasionally, there may be a scratching or engraving on it which may indicate the tie to a particular person. For example, such a scratching on the QM specimen noted above was interpreted as representing the hand and extended fingers of its custodian. These items are inherited from parents, grandparents and other kin depending on circumstances. While not always considered highly secret, access to them is restricted.

It is thus the exclusion of coastal people from the customary receipt of these items from west of the study region, which distinguishes them from the inlanders. Senior Garawa and Waanyi people now say that the items were not passed on to Ganggalida people 'because they didn't know'. In these respects, the situation of the coastal mainlanders was identical with that of the Wellesley Islanders.¹¹

Spearthrowers

While inland artisans made three types of spearthrower, the coastal people along with all the occupants of the Wellesley Islands, made only one of these. It is known in Garawa, Waanyi and Ganggalida as *murrugu*, and Memmott (1979a: 110) reports the same term ('*murraku*') for 'Lardil'. It is cut from one straight piece of cylindrical wood so that the distal end has a raised notch which slips into the hole typically at the back of spears (QM QE16/113, see Fig. 5). Roth (1909: 200) describes it in some detail and refers to it as 'a very primitive form of implement met with in the Wellesley Islands, and on the adjoining mainland in the neighbourhood of Burketown . . .', and illustrates it in his Plate LVIII, Fig. 14 (and see also Roth 1902: 15). As Roth mentions, this is a very light implement; contemporary people say it is commonly made from the *farggulta* tree (*Thespesia populneoides*), or one of several other light woods. Presumably Roth designates it as 'primitive' because of the notion that its construction is simple relative



FIGURE 5. Three types of spearthrower made in the study region. The bottom one (QE 16/1113) was made throughout mainland coast, island and inland areas, while the other two were made only in the inland areas. (Courtesy Queensland Museum.)

to other types, or at least somehow less developed. This is further made clear when he notes (1902: 15) that it is identical (except in its size) with a 'toy wommera' used commonly throughout north Queensland by boys emulating the fighting behaviour of men. However, both coastal and inland people state its advantage over other types of spearthrower to be that there is no problem with a separate attached peg coming loose. It can not be seen as under-developed in terms of functional performance.

The two further types of spearthrowers made and used by Garawa and Waanyi people, but not in the coastal mainland area or on the islands, are termed *ngaliga* and *wujula*. The former is again a cylindrical straight piece of wood, but with a separate wooden peg (known in Garawa/Waanyi as *ngurru*) attached to the distal end, usually with gum (QM QE11/53, obtained from Turn Off Lagoon on the Nicholson River). The latter type is flat and linear with a large notch forming a spatulate proximal end. The peg is attached to the distal end at an acute angle to the face (Robins 1980: 58), (UQ 1813; see Fig. 5). Roth (1909: Plate LXI, Figs 1–4) describes these two types and notes (pp. 200–201) them as 'occasionally to be found in the area around Burketown, but ... certainly not of local manufacture, being brought in from eastward'. However, I am sure the editor's footnote replacing 'eastward' with 'westward and southward' represents what Roth intended; though it can be noted that the editor's correction was overlooked in McCarthy (1939: 419). My information is certainly that these two latter types were made and used in Garawa and Waanyi territory to the west and southwest of Burketown.

Spencer & Gillen (1904: 668–670) describe and illustrate the *ngaliga* type as often found to the west of the study region, and state that it is traded 'eastwards towards the Gulf'. The one they illustrate

is in fact from the 'Anula [Yanyula] tribe' so the type apparently reached the saltwater domain to the west of the coastal Ganggalida area. It is shown with a human hair-string tassel at the handle end, and, although Roth (1909: 201 and Plate LXI) also shows such a tassel, this is now said not to have normally been added by Garawa and Waanyi people. In another publication, Spencer & Gillen (1969 [1899]: 578–582) give the name for this type (said to be made by 'the Waimbia [Wambaya] tribe') as '*Nulliga*', clearly the same term as *ngaliga* given above. In both publications, Spencer & Gillen also show the *wujula* type in areas to the west of Garawa and Waanyi territory.

While neither of these latter two types are now said to have been customarily manufactured by coastal people or Wellesley Islanders, some coastal incorporation of these items and the skills to make them did occur during post-contact times. One museum specimen (UQ 1814) of the *ngaliga* type obtained in the 1940s, is recorded as having been made by a man at Mornington Island who learned about the style from mainland sources.¹²

Spears

Four types of spear can be distinguished. In general, spear shafts are now commonly known as *mugura*, but are distinguished according to the kind of tree they are cut from. However, spear types are distinguished mainly according to the nature of their heads.

The first type was used throughout inland, coast and island settings; it is known by the word for prong in all languages, and usually two or three prongs are attached to a shaft (QM QE11/53, see Fig. 6). The manner of construction described and illustrated by Roth (1909: 190–191) for the Wellesley Islands, appears applicable to both the coastal Ganggalida and the inland Garawa and Waanyi. (However, with the incorporation of European wire, the prongs have been commonly attached by wedging them into a hole made in the end of the shaft.) To summarise the earlier technique, the wooden prongs are fitted neatly against grooves cut along the shaft and then tied with string. These spears were used mainly for fish, but also for animals such as goanna in some circumstances, in both coastal and inland contexts.

The second type of spear head (*babagana* [Garawa] and *jimindi* [Waanyi], but not known by a term in Ganggalida) is stone, and the spear was used to hunt large animals like kangaroo and emu (QM QE4278, obtained in the Burketown area). The stone items are said not to have been manufactured in the coastal area, but were apparently procured by coastal people from various inland sources. They were thus used by inland and coastal people both as knives and as spear heads fitted to shafts (cf.

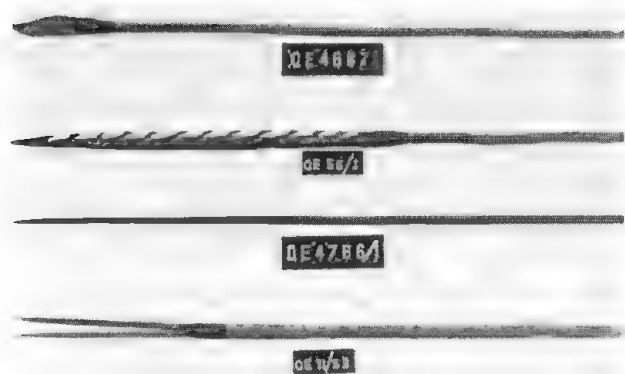


FIGURE 6. Four types of spear made in the region. The QE 4766/1 type was not used in inland areas, while the stone flakes for the QE4687 type had to be imported into the coastal area. (Courtesy Queensland Museum.)

Spencer & Gillen's [1969 (1899): 592–593; 1904: 640–656] accounts of the manufacture of these stone blades and their multiple uses, upon which McCarthy [1976: 35] appears to rely). Roth (1904: 18, 22) notes that the stone blades were made 'along the ranges up the western border north from Lawn Hill, etc.', and that small bundles of them rolled up in tea-tree bark were bartered. He specifically mentions (1909: 190) 'the stone-spears of Burketown, Point Parker [i.e. coastal Ganggalida country], and the ranges along the Queensland Northern Territory Border [i.e. inland Garawa/Waanyi country]'; and, it may be noted, he also comments (1904: 22) on a 'large import' of such items occurring 'from the Northern Territory, across the border from Wollogorang [Station] southwards' to his North-West-Central districts.

Tindale (1974: 122, 228) states that 'Karawa' people traded stone knife blades to the east generally, and that Mornington Islanders sent young marriageable girls in return for these items. He also mentions McCourt's claim (published soon after [McCourt 1975: 80, 108]) to have discovered the origin of the long stone spear points found by Tindale 'on Bentinck Island . . . and on the adjacent [mainland?] coastline'; McCourt says these were quarried and made in the Wollogorang-Calvert Hills Stations area, on the Calvert River, near Redbank Mine, etc., — that is, in Garawa territory. Contemporary old Garawa people certainly state that a number of places, including this area, were sources of stone used for both long knives and spear points. Indeed, they take pride in the Garawa knowledge of the manufacture of various kinds of stone tools.

However, how far the stone blades made in Garawa territory reached, remains an open question. Although a comment from Roth (1901a: 4) states that strong shell tools take the place of knives and scrapers on Bentinck Island, 'as on the

mainland', his statement (quoted above) about the presence of stone spear-heads in coastal Ganggalida country is quite unambiguous. Yet none of Roth's data describe these items for the Wellesley Islands, nor does Memmott's (1979a) recent work with contemporary 'Lardil' people mention them. Thus, Tindale's assertion that the stone spear-blades reached Mornington Island may be incorrect. Tindale (1977: 267) himself notes that such stone items were never used on Bentinck Island, though he was shown one on Sweers Island which had been brought by visiting mainland Aborigines accompanying European men.

The third type of spear is known in Garawa and Waanyi as *ngarrigidigidi* (*ngarrgadaba* = to spear), (eg QM QE56/1, obtained from Turn Off Lagoon). The long wooden head is barbed on one or both sides, making it difficult to remove. This is a fighting spear, said to have been used in a variety of conflict and dispute contexts. Coastal Ganggalida people are said to have similarly used this spear. Memmott (1979a: 110) also describes it for the 'Lardil'.

The final type¹³ was apparently not made or customarily used by the inland people. It consists of a light wood shaft attached to a long smooth hardwood point of approximately the same length as the shaft (QM QE4766, Nos 1–7). The method of attachment is apparently unusual (R. Robins, Queensland Museum, pers. comm.), being the hafting together of the two sticks whose ends have been sliced at much the same angles. The join is bound in a distinctive fashion and no gum is used. This method of attachment is quite different from that customarily used by inland people. The spear was used for large marine animals such as dugong and sea turtle and is known in Ganggalida as *miyalda*. Memmott (1979a: 110) describes the same spear for the 'Lardil' on Mornington, where it is known as *miya*.

Fishing and other methods of obtaining aquatic foods

Both inland and coastal people used pronged spears and nets to obtain a wide range of aquatic foods. A large amount of knowledge is particular to certain environments, and this is especially so in relation to 'saltwater country'. Yet coastal people clearly also used the same techniques as inlanders when ranging into the vicinity of fresh waterholes, for example, 'poisoning' techniques involving the placing of particular plants in the water, which cause fish to float to the surface where they can be easily obtained. As well, not all practices are the result of environmental determination. For example the 'squeezing' of stingray flesh in the coastal area or swordfish flesh in both saltwater and freshwater

areas, appears to be done solely because the taste of the meat is preferred without the 'sticky stuff' which comes out when it is squeezed.

Nets were used by both inlanders and coastal people. Despite size variation they were all made from string which was produced by rolling together either strands of certain grasses (QM QE1912), or strands of bark from certain trees — the bark of *Hibiscus tiliaceus* is particularly useful for this purpose in coastal areas, but other trees such as kurrajong (*Brachychiton* sp.) or black wattle (*Acacia hemsleyi*) are used throughout the study region. There are two methods of net usage in both coastal and inland areas. The first involves four people, one at each corner of a big net, dragging it so that two corners are held near the bottom and two at the surface, and the two ends are moved so that the net forms part of a circle, eventually dragging its contents on to the shore. In the second method, two sticks are attached to two sides of the net which is moved vertically through the water while other people frighten fish into it; when a weight is felt against the net, it is taken to the shore.¹⁴

It remains uncertain whether line and hook fishing was done in this region. Roth (1903: 5) states that 'before the advent of the Europeans, such articles in any material (shell, bone, etc.) were unknown'. Some Aboriginal people today agree with this view. Some remain unsure, and others claim that hooks and lines were in use prior to colonisation. Indeed, a shell type of hook certainly exists, obtained in 1882 from the Settlement Creek area (QM QE5924, see Fig. 7): a grass string line is attached to a groove cut around the top of the shank of a shell hook, and what are designated in the associated documentation as several shell sinkers, are tied to the line. Roth's (1901b: 20) general comment for other areas where he found usage of fish hooks, that weights or sinkers are never used, is thus also problematic. It seems most likely that the hook shown in Fig. 7 was an isolated recent import into the region, possibly originating from the Torres Strait Islands.¹⁵

The term *wardugu* has been given by several contemporary old people to refer to fishing lines complete with hook (cf. Keen's [1983: 294] translation of the term as 'fish, hook, wire, line'), and while the term *bala* is given for the hook itself, it is more generally applied to any kind of forked shape, whether as part of an implement or simply the fork formed by tree branches. Some people today, both inlanders and coastal people among them, state that hooks were also made from emu, kangaroo and pelican bone. One specific account from two older Garawa men is that 'goanna collar bone' and 'catfish jaw bone' are suitably hook shaped and were used as such by Garawa people.



FIGURE 7. Fishing line with shell hook and sinkers, collected in 1882 in the Settlement Creek area. (Courtesy Queensland Museum.)

Various kinds of grub, frog, insect and shellfish are now used as fish bait, as well as the fruit from the fig tree (*Ficus racemosa*). If line fishing has indeed developed since the early phases of European impact, it represents an innovation which has occurred throughout inland, coastal and island settings.

Of particular interest in this region is a large complex of stone fish traps on the Wellesley Islands and the adjacent mainland coast. Stone walls as traps are said to have been constructed across inland watercourses at narrow places, and these were mainly used during 'flood time' (the wet season) when the stream ran strongly due to the extensive wet season rains. More temporary sapling fences were also constructed across both inland and coastal watercourses; in the coastal area stakes were stuck in the bed at an angle so that the receding tide would push deliberately placed bushes and other debris against them. However, the inland traps appear to have been much less important in the food production process than their coastal equivalents.

The extensiveness of the stone traps throughout the islands and adjacent mainland coast, suggest their importance in the food production process. Over approximately 470 km of coastline, 334 traps have been recorded, one trap per 1.4 km of coastline (although there is considerable variation in the density of traps throughout the islands and adjacent mainland); (see Robins *et al.* [n.d.] for details of the physical features of the traps, their distribution and relevant ethnographic data). Figure 8 shows one of the mainland trap sites (at Bayley Point). This series of traps extends along the shore-line for approximately 400 m, and from the shore-line up to approximately 150 m out on to mudflats, to the edge of an extending rock platform. The receding tide would leave contained (if not

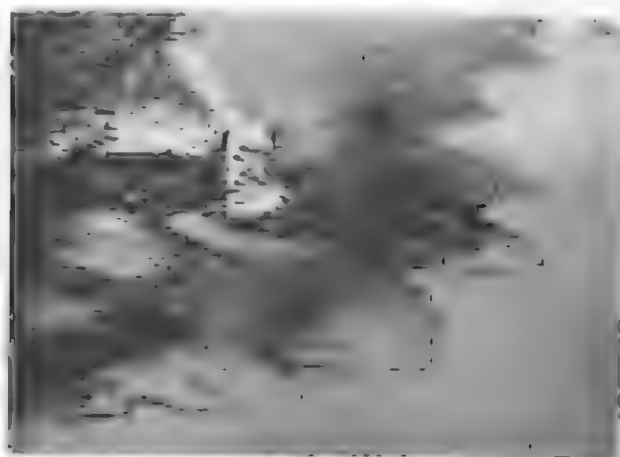


FIGURE 8. Stone fish trap complex at Bayley Point on the mainland coast opposite the Wellesley Islands. (Courtesy Connah/Jones Aerial Archaeology, University of New England.)

exposed in some instances) fishes (including shark and stingray), and at times sea turtle and dugong. On a visit to these traps in 1983, Ganggalida people also used a pronged spear to obtain crabs from within crevices under the trap wall. The stone wall traps represent a highly developed (and apparently durable) form of food production technology, which is distinctive of the coastal economy on the mainland and the Wellesley Islands.

Watercraft

The distinctive triangular shaped raft of the Wellesley Islands area (known in 'Lardil' as *wulpa*) has been described in various sources (e.g. Memmott 1979a: 111). It is clear from contemporary accounts that these were also used by coastal mainlanders opposite the islands who refer to it as *walbuwa*. Roth (1908: 161) confirms this fact, and describes the raft as:

formed of numerous logs of 'white mangrove' tied together at the butts as well as at the extremities, with the result that it is much narrower forward than at the stern. On top is placed some sea-weed, a sort of cushion for the voyager to sit upon. With such frail craft the [Aborigines] will not only visit island and island, but even cross over to the mainland, usually on the one course, making for a spot somewhere in the vicinity of Point Parker.

Elsewhere, Roth (1903: 3) notes again that: 'There is no doubt whatever that communication goes on here [from Forsyth Island] between the mainland via Raines [later to be called Paines] and Bayley Islands and Bayley Point'.

Davidson (1935: 40), in his survey of Aboriginal watercraft, states that apart from in this relatively limited area of the southern Gulf of Carpentaria,

this type of raft existed elsewhere only on a section of the north-western Australian coast, and the question of its advantages and disadvantages for those who adopted it remains an interesting research issue. Davidson (1935: 39-45) reconstructs an historical developmental sequence for watercraft where the triangular raft was invented earliest, but had then 'given way' along most of the northern Australian coast to the supposedly more sophisticated and preferred sewn bark and dug-out canoes. He makes no direct comment on why the raft was retained in two regions. However, a cautionary comment is surely required here against the notion that the rafts would have necessarily been inferior to the canoes. The point is similar to the one made above concerning Roth's attribution of primitiveness to the coastal (and islands) spearthrower. While the raft may appear to involve less sophisticated construction techniques than the canoes, an assumption that the canoes were better suited than rafts for travel in all circumstances may well overlook certain advantages possessed by the latter. For example, a feature of the rafts, particularly the larger ones, may have been greater stability which may have enabled safer transportation across shallow sandbanks and channels, of larger numbers of children and valued items (including burning cinders to be used to re-kindle fires).

Within the study region of this paper, Ganggalida people on the coast just to the west of the Wellesley Islands are said to have used the raft, but to a much more limited extent than the Gananggalinda people directly opposite the islands. It was not manufactured or used by the inlanders. Garawa people are said to have been familiar with the manufacture of the sewn bark canoe (termed by them *wulganyi*) from the bark of the messmate tree; however, they only used it occasionally, most likely when moving over wide sections of the lower reaches of such watercourses as the Robinson and Calvert Rivers and Settlement Creek. While Ganggalida has a similar term for this type of canoe (*wulgunda*), the coastal people are said to have used it even less than Garawa people. No suitable messmate bark is apparently available in the coastal country. The sewn bark canoe was thus used only to a limited extent east of Yanyula territory, and the above data fill the gap mentioned by Davidson (1935: 35) concerning its distribution west of the Wellesley Islands.

It was the Yanyula people from the coastal areas far to the northwest of the Wellesley Islands, who are now regarded throughout the region as having been the experts with bark canoes. It was they also who came from the northwest in dug-out canoes, which had apparently diffused as far eastwards in the Gulf as the vicinity of the Sir Edward Pellew Islands in Yanyula territory, having been initially

introduced into northern Arnhem Land by Macassan visitors well prior to the European presence in the Gulf (Davidson 1935: 20–24). Dug-outs are now known generally by the same term, *muwarda*, as that given to all European-style boats regardless of their size. Whether Keen (1983: 278) is correct in asserting that this term (her '*muwata*') derives from the English word 'motor', it is most likely that dug-outs were known in the study area before motor-driven boats were brought in by Europeans. Contemporary coastal Ganggalida old people know how dug-outs were made from large-girthed trees of certain kinds (for example, *Canarium australianum*). However, while such trees may be found in their country, only a small number of dug-outs were apparently made here following the introduction of steel axes and the increased eastwards migration of Yanyula people with dug-outs after colonisation.

Material culture — a Summary

In summary, a longitudinal fluting mark was used in decoration by Garawa and Waanyi artisans, but not in the Ganggalida mainland coastal area nor in the Wellesley Islands. This mark is now recognised as distinguishing artefacts as belonging to the cultural bloc extending from Garawa and Waanyi territories to the west and southwest. The adze-type implement used to make the fluting was not manufactured in the coastal or island areas, and hence the wooden coolamon could also not be produced. There was no established stone tool working tradition on the coast or in the islands, whereas Garawa and Waanyi people speak with pride of the stone tool production techniques used in earlier times. Shell cutting tools appear to have taken the place of stone tools along the mainland coastal strip and in the islands. Pearl shell pendants were received by Garawa and Waanyi people through trade from far to the west and southwest, but these were not passed on to coastal Ganggalida people or to Wellesley Islanders.

Coastal mainlanders and Wellesley Islanders made only one type of spearthrower, whereas the inlanders produced two further types as well. Of the four spear types in the study region, two were used across inland, mainland coast and island areas, one was produced only on the coast and islands, and one (with a stone blade as the head) was produced only among inlanders, although mainland coastal people (and possibly North Wellesley Islanders) received the stone blades through trade to a certain extent.

Aquatic resources were obtained by use of spears and nets throughout all parts of the study region (and line fishing appears to have been adopted across the region, with the probable exception of the South Wellesley Islands, from early phases of

European colonisation). Large stone wall fish traps were used only in mainland coastal areas and throughout the islands. Unlike both inlanders and Yanyula coastal people to the northwest, coastal Ganggalida people and Wellesley Islanders used only rafts as watercraft.

CONCLUSION

This paper has compared aspects of inland, coastal and island societies. The most detailed data have been given for traditional material culture, and this has indicated a substantial degree of similarity between coastal mainland and islands societies, compared with nearby inland society to the west and southwest. As 'saltwater people' occupying 'saltwater country', the coastal mainlanders can be regarded as part of the island cultural bloc in significant respects. Yet the material culture of coastal mainland society has simultaneously emerged as similar to that of inland society in *certain* respects, and if further aspects of material culture were to be studied closely, a number of differences between mainland coast and the islands could well become evident.¹⁶ While the material culture repertoires of the mainland coast and islands are strikingly similar in significant ways, it would be inaccurate to define them collectively as a homogeneous material culture tradition completely separate from that of the inland.

The same point was made when summarising the comparative data for the region on language, kinship and social organisation, and genetics. The paper has described a complex pattern of overlapping cultural and other forms, with no area emerging as completely distinctive. This generalisation includes the situation of the Bentinck Islanders, despite the literature in support of their alleged lengthy isolation. At least with *W_N* demonstrated otherwise, we must recognise that the differences between Gayardild society and that on the North Wellesley Islands and the coastal mainland, are apparently no more substantial than the differences between the mainland coast and inland.

The main concern of the paper has been to consider the situation of coastal mainland dwellers adjacent to major off-shore islands society. The generalisation of this paper is that the relationship with the North Wellesley Islands societies in particular, has reinforced the maintenance of cultural differences between coast and inland societies on the mainland. This is not to argue for uni-directional influence from the islands to the coastal mainland. Indeed, some of the data indicate major areal influence from the mainland to both the North and South Wellesley Islands (e.g. the existence of an Aranda type kinship system

throughout the study region). However, the North Wellesley Island societies should not be viewed as without influence on mainland coastal society. In this sense, I am arguing that those mainland-island relations which entail regular contact should be viewed as similar to relations among peoples on the mainland. It may be that the environmental similarities in this region between the mainland coast and parts of the off-shore islands, particularly engender the cultural similarities dealt with in this paper (especially in the aspects of material culture traditions which have been considered). However, the implication for studies in other regions is that when comparing island and mainland societies in Aboriginal Australia, particular attention should be paid to the environment and society of the immediately adjacent mainland coast, as well as to societies located further inland.

ENDNOTES

1. The name of this language has been given as 'Yukulta' in the literature (Keen 1983). However, the term 'Ganggalida' was predominantly used for the language and a group of people at the time of my research. The latter term can be translated as meaning 'language' or 'talk' (see Trigger [1985: 340-49] for further discussion of the relationship between these two terms).
2. The language of the Mornington Islanders is more conventionally spelt 'Lardil' (see e.g. Memmott 1979b). However, except where quoting from works using this spelling, I will use the mainland Aboriginal expression 'Layardilda'.
3. Elsewhere (Trigger 1987b), I have dealt in detail with the problematic issues entailed in using language names to designate 'tribal' units in this region. In this paper, such expressions represent a predominant view among Aboriginal residents which glosses separable areas of land and associated bodies of tradition by the use of language names.
4. Indeed, Evans (1985: 7-8) describes the 'basic "isolation"' (i.e. distinctiveness) of the broader 'Tangkic subgroup' of languages, including those throughout the islands and Ganggalida and Nguburiŋj on the mainland, when compared with other Aboriginal languages.
5. Evans (pers. comm.) has speculated that the etymology of this term may be derived from *kanatya* — 'to burn' and *kalitya* — 'to jump' (see Keen 1983: 272); hence, these people may have been known by a term for 'flames jumping up' or bushfire at times visible from the vantage point of other coastal people.
6. This is not to imply that coastal mainlanders regarded even the small close off-shore islands (Bayley and Pains) as without environmental features differentiating them in more specific respects from the 'islands' in mainland 'saltwater country'. Certainly, the larger off-shore islands are much more diverse environments than both the smaller off-shore islands and the sand ridge 'island' areas within the mainland 'saltwater country'; (see Memmott [1979b: 45-65] for a discussion of the land forms and ecology for Mornington, and Tindale [1962a: 280-288] for relevant information concerning Bentlock). It would be interesting to investigate whether the larger off-shore islands are designated as 'islands' (*murndamurra*) in the coastal mainland perspective. Minimal data indicate that they are in fact regarded as *wambalda* (or 'land'), though coastal mainlanders would presumably identify as *murndamurra*, areas within the larger off-shore islands similar to the sand ridges in mainland 'saltwater country'.
7. Simmons *et al.* (1964: 75) themselves point out for the whole population tested in this region, that 'about one-half, . . . were of mixed tribes and, of course, their earlier history is unknown'. Elsewhere (Trigger 1987b), I have discussed the necessity of examining the linguistic (or 'tribal') affiliations of individuals' four grandparents if this matter is to be adequately researched. The basis on which individuals state primary affiliation with, say, father's language rather than mother's, involves a variety of social factors. Hence the possibility of defining clearly a relatively enduring endogamous population in 'tribal' terms, from the statements of individuals, is fraught with difficulties.
8. Throughout the paper, items located in museum collections are identified by placing their registration identifications in parentheses. The letters 'QM' indicate that the item is in the Queensland Museum collection, and 'UQ' indicates the University of Queensland Anthropology Museum collection.
9. Roth obtained wooden coolamons at Burketown in 1901 and Forsyth and Mornington Islands in 1903 (items 13359, 13360, 13361 respectively, in the Australian Museum register of the Roth Collection), however it is most likely that these would have been manufactured in inland areas.
10. Mr Tommy George, of Waanyi and Garawa descent, inspected museum collections in Brisbane and Canberra in 1980 and in Brisbane during March 1984; some of the information he provided is contained in a transcription of an audio tape made after his 1984 work (George 1984).
11. Several authors (see Mulvaney's [1969: 96; 1976: 83] summary maps) have documented pearl-shell as an item traded over very long distances, and by these accounts it is possible that it also came into the study region from an easterly direction via Cape York Peninsula. However, it is rather the accounts of it coming originally from the very distant Kimberley coast (e.g. McCarthy 1939: 96-98) which are consistent with contemporary Aboriginal opinion in the study region.
12. Memmott (1979b: Table 7) notes 'vuijala' as the name given by 'Lardil' people to a spearthrower of the typical west Cape York kind with attached shells at the proximal end, and he says they reached Mornington Island only in recent times. While it appears the 'Lardil' have thus borrowed this term, both mainland coastal and inland groups remain unfamiliar with the Cape York type and

would most likely simply refer to it as being from 'another country'.

13. Roth (1902: 15) refers to a kind of toy spear used in games by young boys: 'so far observed . . . only among the coastal blacks to the west of Burketown, and at Wollgorang (Northern Territory border)'. However, while the few people of whom I have enquired state that it was used, I have no data to compare with Roth's description of it.

14. The large 'dugong net' described for the 'Lardil' by Memmott (1979a: 112, 118) does not appear to be known by contemporary Ganggalida people, though whether it was once used in the coastal mainland area remains uncertain.

15. The hook collected from the region (Fig. 7) appears to be of the 'bent pin' type which is discussed by Massola (1956: 11, 15) as having been possibly introduced from the Torres Strait. Anell (1955: 114-115) says that all fish hooks in Australia were 'undoubtedly' introduced from the Torres Strait, and suggests that this occurred 'relatively late', that is during the recent past.

16. Memmott's (1985) ongoing work comparing 'Lardil' and 'Kaiadili' material culture repertoires indicates some significant differences between aspects of the material culture of the North and South Wellesley Islanders, the most striking being that the Gayardil had a much smaller number of artefacts. It is most likely that further research would indicate that the Gayardil also differed from the mainland coastal Ganggalida in this respect.

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THE FOSSIL HISTORY OF THE EMUS, DROMAIUS (AVES : DROMAIINAE)

BY C. PATTERSON & P.V. RICH

Summary

The oldest known emu is *Dromaius gidju* n. sp. from the medial Miocene Kutjamarpu fauna at Lake Ngapakaldi in northern South Australia. This form, based on a partial hind limb, is smaller and has relatively shorter and less mediolaterally compressed hind limb bones, and less reduction of the medial and lateral digits than in the living form. *D. gidju* thus appears to be less specialized for a cursorial lifestyle, being somewhat intermediate between the forest dwelling cassowaries and the highly cursorial living emu, *D. novaehollandiae*. Fossils from the Late Miocene and Early Pliocene may be allied to *D. gidju*, but more material is needed to allow confident assignment. *D. ocypus* from the medial Pliocene Palankarinna fauna at Lake Palankarinna, northern South Australia, is intermediate in size between *D. gidju* and *D. novaehollandiae*. In addition, its tarsometatarsus is decidedly shorter relative to width than that in *D. novaehollandiae*, thus indicating it is not as highly adapted for cursorial life as the living emu. Essentially all other emu fossils, Late Pliocene-Recent, appear to belong in *D. novaehollandiae* including : *D. 'patricius'*, *D. 'gracilipes'*, and '*Metapteryx bifrons*', all defined originally by C.W. De Vis. The only exceptions are the King Island emu (*D. ater*) and the Kangaroo Island emu (*D. baudinianus*). Whether there was greater size variability in Pleistocene emu populations and whether a separate species of emu once inhabited Tasmania are problems yet to be resolved once larger collections of both living and fossil emus can be measured and analyzed.

THE FOSSIL HISTORY OF THE EMU, *DROMAIUS* (AVES: DROMAIINAE)

C. PATTERSON & P. V. RICH

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The oldest known emu is *Dromaius gidju* n. sp. from the medial Miocene Kutjamarpu fauna at Lake Ngapakaldi in northern South Australia. This form, based on a partial hind limb, is smaller and has relatively shorter and less mediolaterally compressed hind limb bones, and less reduction of the medial and lateral digits than in the living form. *D. gidju* thus appears to be less specialized for a cursorial lifestyle, being somewhat intermediate between the forest dwelling cassowaries and the highly cursorial living emu, *D. novaehollandiae*. Fossils from the Late Miocene and Early Pliocene may be allied to *D. gidju*, but more material is needed to allow confident assignment. *D. ocybus* from the medial Pliocene Palankarinna fauna at Lake Palankarinna, northern South Australia, is intermediate in size between *D. gidju* and *D. novaehollandiae*. In addition, its tarsometatarsus is decidedly shorter relative to width than that in *D. novaehollandiae*, thus indicating that it is not as highly adapted for a cursorial life as the living emu. Essentially all other emu fossils, Late Pliocene-Recent, appear to belong in *D. novaehollandiae* including: *D. patricius*, *D. gracilipes*, and *Metapteryx bifrons*; all defined originally by C.W. De Vis. The only exceptions are the King Island emu (*D. ater*) and the Kangaroo Island emu (*D. baudinianus*). Whether there was greater size variability in Pleistocene emu populations and whether a separate species of emu once inhabited Tasmania are problems yet to be resolved once larger collections of both living and fossil emus can be measured and analyzed.

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The living emu (*Dromaius novaehollandiae*) is the second largest living ground bird, exceeded only by the ostrich in size. Today and in the past, emus have been restricted to Australia, and their origins are not understood.

The fossil record of emus begins in the Miocene, with two now extinct species occurring one each in the Pliocene and the Miocene of northern South Australia. The Quaternary King Island and Kangaroo Island emus seem to belong in two separate species. All other fossil emus, mainly Pleistocene, however, are very similar to and most probably conspecific with the living *D. novaehollandiae*. It is very likely, however, that the history of emus on the Australian continent is much older than currently understood because of the general lack of a pre-Miocene terrestrial record.

Although the Pleistocene emus are currently indistinguishable from the living emu, the Tertiary species are distinct. The hind limb of the single Miocene form is not as cursorially adapted. This species has a tarsometatarsus that is shorter and more robust, and the lateral and medial digits of the foot are not as reduced as in the living emu.

This paper reviews fossil emu material and outlines the major evolutionary trends demonstrated by the dromaiines during the last 20 million years.

The following abbreviations are used:

AM Australian Museum, Sydney
AMNH American Museum of Natural History, New York

table
B.P.	Years before present
C.	Cranium, crania
Cor.	Coracoid
CSIRO	Commonwealth Scientific and Industrial Research Organization, Division of Wildlife and Rangelands Research, Canberra
d	Distal
diapop.	Diapophyses
est.	Estimated
F.	Femur
Fib.	Fibula
HM	Hunterian Museum, Glasgow
hum.	Humerus
juv.	Juvenile
L	Left
M	Mandible
MM	Geological and Mining Museum, Sydney
NMV	Museum of Victoria, Melbourne
p	Proximal
Ph.	Phalanx, phalanges
postzyg.	Postzygapophyses
QM	Queensland Museum, Brisbane
QVM	Queen Victoria Museum and Art Gallery, Launceston
R(r)	Right
SAM	South Australian Museum, Adelaide
SIAM	Smithsonian Institution - American Museum of Natural History Expedition Field Numbers, Washington, D.C. and New York
Sk.	Skeleton(s), many skeletal elements
St.	Sternum
Syn.	Synsacrum

T2, T3, T4	Trochleae II, III, IV
Tib	Tibiotarsus
Tmt	Tarsometatarsus
V	Vertebrae
UCMP	University of California, Museum of Paleontology, Berkeley
WAM	Western Australian Museum, Perth

PREVIOUS WORK

There is surprisingly little in the literature concerning the fossil emus of Australia (see Table 1). The first reference to a specimen supposedly related to emus was, in fact, a moa, '*Dinornis queenslandiae*', described by De Vis (1884) from the Darling Downs, Queensland. Some later workers considered this specimen (e.g. Hutton 1893, Miller 1963) to be related to the emus and cassowaries. Scarlett (1969), however, found the fossil could be assigned to *Pachyornis elephantopus*, probably collected from a midden on South Island, New Zealand, and thus it is not a valid Australian record, and certainly not an emu.

In 1888 De Vis described a new species of emu, *Dromaius patricius*, from a proximal end of a right tibiotarsus (QM F5547) and the distal end of another tibiotarsus (QM F5548). In the same paper he provisionally referred a left coracoid (QM F1120) to the same species. These three fossils were from King Creek, Darling Downs, in south-eastern Queensland. De Vis (1892) considered the whole of the Darling Downs sediments to be much the same age, but it is now known that these fossil-bearing deposits represent a range of ages. The Chinchilla fauna is likely to be of Late Pliocene age. On the other hand, the Darling Downs fauna of the eastern part of the Downs, including King Creek, is of Late Pleistocene age (Woods 1960, Stirton *et al.* 1968, Rich 1979). Later De Vis (1892, 1905) also referred a femur fragment, three tarsometatarsi, and a partial synsacrum (QM F5549) to *D. patricius*. The referral of the synsacrum is especially noteworthy. De Vis considered that because of its size, the fragment must have been from a cassowary or an emu, but: 'as no extinct cassowary is known yet in Australia, it seems almost necessary to attribute the present fossil to the emu *D. patricius*' (De Vis 1905: 25).

In 1892 De Vis set up another species of emu, *Dromaius gracillipes*, based on a distal left tarsometatarsus (QM F1142). In the description De Vis omitted to note the location from which the specimen was collected, but the museum label associated with the specimen indicates that it was from the Darling Downs. In this article De Vis (1892) also described a supposed kiwi, '*Metapteryx bifrons*', again without giving a location.

Spencer (1906) described *D. minor* of King Island, Bass Strait, Tasmania. The previous exist-

ence of a separate species of emu on this island was almost simultaneously made by Legge (1907), but he withdrew the name. *D. minor* was redefined by Spencer & Kershaw (1910) as more specimens became available, and recently the taxonomic status of this species has been discussed by Parker (1984).

The status of the extinct Tasmanian emu is as yet unresolved problem. Emus were introduced from the mainland in the 1800s, and interbreeding may have occurred (Howchin 1926). Le Souef (1903) gave the Tasmanian emu the specific name *D. diemenensis*. Ridpath & Moreau (1966) considered it a subspecies of *D. novaehollandiae*. The only fossils and recent specimens of *D. diemenensis* collected alive which are known to exist include a femur, a synsacrum, three tibiotarsi, two tarsometatarsi, a cervical vertebra, and a leg lacking the femur and part of digit II (all at QVM) (Scott 1924, 1932), and three eggs (in private collections) (Campbell 1900, Le Souef 1903, Spencer & Kershaw 1910, Dove 1926).

Anderson (1937) described an emu sternum, which is much thicker than those of the living *D. novaehollandiae*, from the Wellington Caves, New South Wales. He suggested it might possibly belong to *D. patricius*.

Miller (1962) restudied *Casuarus lydekkeri*, discussed earlier by Rothschild (1911). The type of the species is a distal right tibiotarsus (AM MF1268). The type locality has been variously given as Queensland, Cooma and Wellington Caves (Miller 1962), but its provenance is uncertain. Its preservation, however, is very unlike that of fossils from Wellington Caves. It is clearly a cassowary, however, and not an emu.

Miller (1963) described a new species of emu *Dromiceius* (= *Dromaius*) *ocypus* based on an essentially complete right tarsometatarsus (SAM P13444) from the Pliocene Mampurdu Sands, Palankarina fauna, Lake Palankarina, South Australia. It is smaller than *D. novaehollandiae*. The tarsometatarsus is evidently the one referred to by Miller in Stirton *et al.* (1961) as a new species of emu with 'proportions of the bone . . . intermediate between those of the emu and the cassowary'.

Miller also assigned four phalanges (UCMP 36849, 60563, 94679, 94680) from Lake Kanunka (UCMP V-5772, Katipiri Sands or possibly Tirari Formation) to the Dromornithidae, possibly *Genyornis newtoni* (Stirton *et al.* 1961). As noted by Rich (1979), however, they actually belong in the genus *Dromaius*. Thus, no dromornithids are known from the Pliocene-Pleistocene Lake Kanunka fauna, and this adds another record for emus.

Rich (1979) refers a left femur (SAM P17104), from Brother's Island, South Australia to *Genyornis newtoni*, but it conforms in all respects to *Dromaius* and should be transferred to that taxon.

TABLE 1. Australian localities producing fossil emus (*Dromaius*).

Locality	Fossil Elements	Rock	Fauna	Age	References
Leaf locality, Lake Ngapakaldi, South Australia	<i>Tmt.</i> , <i>d Tib.</i> , <i>Pes Dromaius gidju</i>	Wipajiri Fm.	Kutjamarpu	Miocene	Stirton <i>et al.</i> 1967, 1968; Rich 1979.
Bullock Creek, Northern Territory	<i>Tmt.</i> , <i>Tib. Dromaius</i> sp.	Camfield beds	Bullock Creek	Late Miocene	Rich 1979
Alcoota (including Rochow locality), Northern Territory	<i>Tmt.</i> frags., <i>Phs. Dromaius</i> sp.	Waite Fm.	Alcoota	Late Miocene	Woodburne 1967, Stirton <i>et al.</i> 1968, Rich 1979, Rich <i>et al.</i> 1982
Lawson-Daily Quarry, Lake Palankarinna, South Australia	<i>Tmt. Dromaius ocybus</i> ; <i>Tib.</i> , <i>F. Dromaius</i> cf. <i>ocybus</i>	Mampuwordu Sands	Palankarinna	Pliocene	Miller 1963, Rich 1979
Lake Kanunka, South Australia	<i>F.</i> , <i>Ph.</i> , <i>R.</i> , <i>Tib.</i> , <i>V. Dromaius novae-hollandiae</i> , <i>Dromaius</i> sp.	Katipiri Sands	Kanunka	Late Pliocene or Early Pleistocene?	Rich 1975, 1979
Chinchilla, Queensland	<i>Syn.</i> , <i>F.</i> , <i>Tmt. Dromaius novae-hollandiae</i>	Chinchilla Sands	Chinchilla	Early to Middle Pliocene	Woods 1960, Stirton <i>et al.</i> 1968, Rich <i>et al.</i> 1982
Darling Downs, Queensland	<i>Cor.</i> , <i>F.</i> , <i>Tib.</i> , <i>Tmt. Dromaius novae-hollandiae</i>	Unnamed	Darling Downs	Pleistocene	Woods 1960, Rich 1975, 1979
King Creek, Queensland	<i>Dromaius novae-hollandiae</i>	Unnamed	King Creek	Late Pleistocene	Baird 1986
Thorlindah, Paroo River, Queensland	<i>Tib. Dromaius novae-hollandiae</i>	Unnamed	Unnamed	Pleistocene	Etheridge, 1889, Rich 1975, 1979
Bingara, New South Wales	<i>V.</i> , <i>Syn.</i> , <i>Tib. Dromaius novae-hollandiae</i> , <i>Dromaius</i> sp.	Unnamed	Bingara	Pleistocene	Anderson 1889, Rich 1975, Marcus 1976
Lake Menindee, New South Wales	<i>Ph.</i> , <i>Tib. Dromaius novae-hollandiae</i>	Unnamed sand lunette	Unnamed	Late Pleistocene	Tedford 1967
Lake Tandou, New South Wales	<i>Dromaius</i> sp.	Unnamed	Unnamed	Pleistocene	Rich 1975
Wellington Caves, New South Wales	<i>Tib. Casuarius lydekkeri</i> ; <i>St.</i> , <i>Tib.</i> , <i>Tmt. Dromaius novae-hollandiae</i> , <i>Dromaius</i> sp.	Unnamed cave sediments	Unnamed	Quaternary	David 1950, Rich 1979, Dawson pers. comm.
Wombeyan Quarry Cave, New South Wales	<i>Tib.</i> , <i>Tmt. Dromaius novae-hollandiae</i>	Unnamed cave sediments	Unnamed	Late Pleistocene	Hope 1971, Rich 1975
?Baldina Creek, near Burra, South Australia	<i>F. Dromaius</i> sp.	Unnamed	Unnamed	Quaternary	S.A.M. Museum label
Brothers Island, South Australia	<i>F. Dromaius novae-hollandiae</i>	Unnamed aeolianite	Unnamed	Quaternary	Rich 1975, 1979

Locality	Fossil Elements	Rock	Fauna	Age	References
Cooper Creek, (includes Katipiri Waterhole and Wurdulumankula), South Australia	<i>F, M Tmt., Syn., V. Dromaius</i> sp. <i>Dromaiinae</i>	Katipiri Sands	Malkuni	Pliocene-Quaternary	Stirton <i>et al.</i> 1961, Rich 1975
Kangaroo Island, South Australia (Several localities)	<i>Sk., Dromaius baudinianus</i>	Unnamed	Unnamed	Quaternary	Morgan & Sutton 1928, Rich 1975, Parker 1984
Lake Callabonna (lower stratigraphic level), South Australia	<i>C., Syn., V., F., Tib. Dromaius novae-hollandiae</i>	Millyera	Lake Callabonna	Pleistocene	Stirling & Zeitz 1900, Rich 1975, 1979
Lake Kittakittaooloo, South Australia	<i>Tmt. Dromaius novae-hollandiae</i>	Katipiri Sands	Malkuni	Quaternary	S.I.A.M. Museum label
Naracoorte (Henschkes Bone Dig and Victoria Fossil Cave) South Australia	<i>M., V., R., Hum., Syn., F., Tib., Tmt., phs. Dromaius novae-hollandiae, Dromaius</i> sp.	Unnamed cave sediments	Unnamed	Pleistocene	van Tets & Smith 1974
Salt Creek, South Australia	<i>F. frag. Dromaius cf. novae-hollandiae</i>	Unnamed	Unnamed	Quaternary	Rich 1975
Warburton River, South Australia (includes Green Bluff locality and Kalamurina).	<i>Syn., Tib., Tmt. Dromaius</i> sp.	Katipiri Sands	Malkuni	Quaternary	Rich 1975
Bone Cave, Western Australia	<i>Tib., Tmt. Dromaius novae-hollandiae</i>	Unnamed cave sediments	Unnamed	Quaternary	
A cave north of Moore River, Western Australia	<i>Tmt. Dromaius novae-hollandiae</i>	Unnamed	Unnamed	Quaternary	Rich (unpublished, 1971, field notes)
Irishtown, Tasmania	<i>Tib. Dromaius diemenensis.</i> Needs review	Unnamed	Unnamed	Quaternary	Scott 1924
King Island, Bass Strait, Tasmania	<i>Sk. Dromaius minor</i>	Unnamed sand rock and dunes	Unnamed	Quaternary	Spencer 1906, Spencer & Kershaw 1910, Jennings 1959, Parker 1984, Rich 1975
Mole Creek, Tasmania	<i>Tib. Dromaius diemenensis.</i> Needs review	Unnamed	Unnamed	Quaternary	Scott 1932
Moybray Swamp, Smithton, Tasmania	<i>Syn., V., F., Tib., tmts. Dromaius diemenensis.</i> Needs review	Unnamed	Unnamed	Quaternary	Scott 1932
Scotchtown Cave, Tasmania	<i>C. Dromaius diemenensis.</i> Needs review	Unnamed	Unnamed	Quaternary	Gill & Banks, 1956

Locality	Fossil Elements	Rock	Fauna	Age	References
Lancefield, Victoria	<i>Tib.</i> , <i>Tmt.</i> , <i>Ph.</i> <i>Dromaius novae-hollandiae</i>	Unnamed	Unnamed	Pleistocene (26 000 B.P.)	Gillespie <i>et al.</i> 1978
McEachern's Cave, Victoria	Many skeletal elements <i>Dromaius novae-hollandiae</i>	Unnamed	Unnamed	Quaternary	McNamara pers. comm.
Buchan Caves, Trogdip Cave area, Victoria	<i>Tmt. Dromaius novae-hollandiae</i>	Unnamed	Unnamed	Quaternary	Rich 1975.

The bird remains in the Riversleigh fauna (Carl Creek Limestone) identified only as close to '*Dromiceius*' in Tedford (1967) have been determined by Rich (1979) to belong to a dromornithid, *Barawertornis tedfordi*, and thus are not a record of emu.

STRATIGRAPHY (see Table 1)

Only a few fossil sites producing emus have been found thus far, and most are of Pleistocene age. Fossils of a new species, *Dromaius gidju*, proposed in this paper, have been found at the Leaf Locality (UCMP V-6313) on the eastern shore of Lake Ngapakaldi, eastern Lake Eyre sub-basin, South Australia (Stirton *et al.* 1967). The sediments that outcrop here, known as the Wipajiri Formation, contain the Kutjamarpu fauna. Diprotodontid marsupials in this fauna are considered more primitive than those in the Beaumaris, Palankarinna, and Alcoota faunas, and have closest affinities with forms in the older Ngapakaldi fauna, known from localities listed in Stirton *et al.* (1968), in the Lake Eyre sub-basin and thought to be of medial Miocene age (Rich *et al.* 1982).

The Camfield beds at Bullock Creek (Bullock Creek fauna), Northern Territory, of probable Late Miocene age, have produced *Dromaius* sp. currently under study by P. V. Rich.

The Rochow locality (UCMP V-6349) at Alcoota, Northern Territory, near Alice Springs, has produced *Dromaius* remains that may be Miocene in age. But, as discussed by Rich (1979), the Waite Formation, which contains the Alcoota fauna, is not well dated at present. The diprotodont marsupials from this locale suggest a date younger than that represented by the Kutjamarpu fauna but older or contemporaneous with the Hamilton fauna. An unnamed rock unit containing the Hamilton fauna is capped by a basalt, which has been dated as 4.35 ± 0.01 m.y. B.P. (or Early

Pliocene) by Turnbull *et al.* (1965) and Turnbull & Lundelius (1970). The sequence is underlain by marine sediments of the Grange Burn Formation assigned to the Kalimnan stage. At present Alcoota is viewed as Late Miocene in age.

Dromaius ocypus was recovered from the Lawson-Daily Quarry (or Lawson Quarry; UCMP V-5769) at Lake Palankarinna, eastern Lake Eyre Basin, South Australia (Miller 1963). The enclosing rocks, the Mampuworu Sands, contain the Palankarinna fauna, and are overlain by the Tirari Formation and the Late Pliocene or Early Pleistocene Katipiri Sands containing the Malkuni fauna at Lake Palankarinna. An age of Middle to Late Pliocene is established by marsupial fossils, in particular *Zygomaturus*, which are more advanced than zygomaturines from Awe, Beaumaris, and Alcoota and yet more primitive than Pleistocene forms (Stirton *et al.* 1968).

Lake Kanunka (UCMP V-5772) in the eastern Lake Eyre sub-basin, South Australia, has also yielded *Dromaius* fossils. The Katipiri Sands or possibly Tirari Formation (see Rich 1979: 61) contains the Kanunka fauna dated as Pliocene or Early Pleistocene (Stirton *et al.* 1961, Rich *et al.* 1982, Tedford pers. comm. 1985).

The Chinchilla locality, south-eastern Queensland (Chinchilla Sands, Chinchilla fauna) also contains *Dromaius*. Several elements of the marsupial fauna appear more primitive than those in the Pleistocene eastern Darling Downs, and Woods (1960) assigned it a Pliocene age. Rich *et al.* (1982) consider Chinchilla to be Early to Middle Pliocene in age.

The distal part of a tarsometatarsus (AM F 58087) of an emu was found in the Australian Museum's 'old collection' and labelled 'mixed plus some from Lord Howe Island'. The fossil is very incomplete and appears to be from a juvenile individual. There are no reliable stratigraphic or locality data available for this form.

All of the other known fossiliferous sites producing emus are Pleistocene in age. For these

Pleistocene sites, as might be expected, some dates are better established than others. Deposition, for instance, of the Darling Downs sediments in Queensland may have occurred at several different times (Rich 1979) during the Pleistocene, and definite ages for specific sites are difficult to determine.

Thorlindah, on the Paroo River, Queensland, is thought by Rich (1979) to be 'probably Pleistocene ... the bird remains were collected along with fragments of 'kangaroos' and *Diprotodon* (Stirling & Zeltz 1900: 44) in a well 20 feet deep'. *Diprotodon* appears to be restricted to the Pleistocene in all precisely dated situations. Emu material indistinguishable from the living forms is known from Thorlindah.

Vertebrate fossil-bearing localities at Lake Menindee adjacent to the Darling River and its major anabranch, western New South Wales, have been radiocarbon dated at $26\,300 \pm 1500$ B.P. and 18 800 B.P. (Tedford 1967). Fossils of *Diprotodon*, *Thylacolea*, *Phascogonus*, *Protemnodon* and macropodids have been recovered. UCMF localities V-5371, V-7185, V-67186 and V-67187 have produced *Dromaius* fossils. Hope (1978) discusses the stratigraphy of the Menindee area in some detail, with reference to the problem of dating the Pleistocene megafauna extinctions. At present the emu fossils from Menindee appear to be Late Pleistocene in age.

At Lake Tandou, New South Wales, several *Dromaius* fossils were found in archaeological excavations. Hope (pers. comm.) states that: 'there is now a reasonable stratigraphy for the lunette [at Lake Tandou], and a lot more dates; the oldest are in the order of 22 000–25 000; and lie at the base of the uppermost stratigraphic unit. The problem ... is in working out where Harry's [Harry Allen, who collected the specimens while doing research toward a Ph.D. thesis] material came from'. Tentatively, a Pleistocene age seems appropriate for these fossils.

Bingara in New South Wales has produced vertebrae and a tibiotarsus of *Dromaius*. The bone bed occurs in a fluvial clay deposit about 39–90 cm thick on the western side of Myall Creek. Remains of *Diprotodon* indicate a Pleistocene age (Anderson 1889).

Also in New South Wales, the Wombeyan Quarry Cave has yielded *Dromaius* fossils. This is not the same cave as Broom Cave or Guineacoe Cave, also in the vicinity of Wombeyan. The Wombeyan Quarry Cave has not been radiocarbon dated, but Hope (1982) believes that it is of Late Pleistocene age. It seems likely that the quarry deposit is older than the 'Broom breccia', but both appear to be of Late Pleistocene age. Other fossils recovered from Wombeyan Quarry Cave include *Protemnodon*,

Sthenurus, *Zygomaturus*, *Palorchestes*, *Thylacolea carnifex*, *Sarcophilus laniarius*, and *Progunia gallinacea*.

There are several bone producing caves in the Wellington Valley area of New South Wales. Different levels and different caves may have trapped animals at various times in the Pleistocene to Recent, perhaps even prior to this (L. Dawson pers. comm.) depending on when they were opened and rescaled (David 1950, Tedford 1967). Emu fossils have been recovered from caves in this area.

Rich (1979: 58) states that *Dromaius* remains were recovered from Cuddie Springs (Mara Creek, SSE of Brewarrina, 16 km ESE of Gilgoin), New South Wales. Anderson & Fletcher (1934) do not mention *Dromaius* in their, admittedly incomplete, list of fossils recovered from this site. Wilkinson (1884) stated that: 'bones of *Diprotodon*, *Sthenurus*, *Macropus titan*, large wombats, large birds probably emus, crocodiles and a gigantic carnivorous lizard, *Notiosaurus* ... are found only within a few yards of the centre of the spring'. Unfortunately, he does not describe or figure these bones, and the large birds may be *Genyornis*, specimens of which were later recovered by Anderson and Fletcher. MM F 19420, unlabelled when found in an old collection, has 'the style of preservation [suggesting] that it comes from Cuddie Springs' (Pickett pers. comm.) but is too large to be *Dromaius*. It appears, instead, to be the internal condyle of a tibiotarsus of a dromornithid, perhaps *Genyornis*. We have been unable to relocate the specimens Rich (1979) assigned to *Dromaius*.

Two Pleistocene cave deposits producing *Dromaius* fossils are known in Western Australia. A cave north of East Moore, Western Australia, has produced a tarsometatarsus of a juvenile emu (unregistered WAM). Bone Cave, near Jewel Cave, has produced an emu tibiotarsus and tarsometatarsus.

Four Pleistocene *Dromaius* localities are known from Tasmania. Scott (1924, 1932) reported a tibiotarsus from Irishtown, a tibiotarsus from Mole Creek, and several elements (a synsacrum, femur, tibiotarsus, two tarsometatarsi, and a cervical vertebra) from Mowbray Swamp, near Smithton, in western Tasmania. The Mowbray Swamp fossil site has been radiocarbon dated at greater than 37 780 B.P. (Gill & Banks 1956). Another Mr Scott found bones of the Tasmanian emu at Scotchtown Cave in association with '*Nototherium tasmanicum*', *Thylacolea carnifex*, and *Palorchestes* (Gill & Banks 1956).

Dromaius minor is known from the Bass Strait island, King Island, Tasmania. Anderson (1914) was of the opinion that the original fossil matrix was a fairly hard, coarse, red-brown sand rock of shallow marine origin. Jennings (1959) stated that

the fossils occurred in windblown sand dunes of Pleistocene to Recent age and that finds from different geological horizons had likely been brought together by winnowing. Separate from the King Island form, the now extinct *Dromaius baudinianus*, is known from Kangaroo Island (Parker 1984).

Several localities along the south coast of Kangaroo Island (Cape du Couedic, Kelly Hill, Eleanor River, and The Brecknells) have produced fossil material (Morgan & Sutton 1928). Rich (1975) states that the age is Pleistocene.

Three Victorian sites, all Pleistocene in age, have produced fossil emus. A partial tarsometatarsus is known from Trogdip Cave, part of the Buchan Caves said by Rich (1975) to be Pleistocene because of the nature of the marsupial fauna also preserved in it.

Many fossils of the Australian megafauna have been recovered from a swamp near Lancefield, Victoria. As well as emus (less than 1% of the bones), *Macropus giganteus*, *Protemnodon*, *Sthenurus*, *Diprotodon*, and a dromornithid, probably *Genyornis*, were found. A sample of the bones themselves was radiocarbon dated at $19\,800 \pm 450$ B.P., while charcoal in the channel fill in and upon which the fossil deposit rests provides a maximum age for the bones of $26\,000 \pm 500$ B.P. (Gillespie *et al.* 1978).

A third Victorian site which has produced emu fossils is McEachern's Cave in western Victoria. According to Wakefield (1967, 1969), due to the funnel shape of the entrance the cave has acted as a death trap for terrestrial animals. Gravitational movement, movement of trapped animals and water action were responsible for considerable mixing of cave sediments. The fossils are Late Pleistocene to Recent in age. A sample of mammal bones from the top layer of the Pleistocene sediments gave a radiocarbon date of $15\,200 \pm 320$ B.P. Extinct Pleistocene species found in the cave include *Sarcophilus laniarius*, *Zygomaturus trilobus*, *Thylacoleo carnifex*, *Sthenurus* spp. and *Protemnodon* cf. *brehus*.

The remaining sites from which fossil emus have been recovered are all South Australian. From Brothers Island, Coffin Bay, about 50 km WNW of Port Lincoln, a femur fragment SAM P17104, referred to *Genyornis newtoni* by Rich (1979) but actually *Dromaius*, was found in an unnamed aeolianite of sand and shells. As similar deposits on the island have produced *Sthenurus* cf. *brownei* (Tedford in Rich 1979), a Pleistocene age is indicated.

A number of Pleistocene localities collected by J. W. Gregory (1906) and later by joint expeditions from the University of California and the South Australian Museum, occur in the eastern Lake Eyre

basin. The fossils were found as 'float' or in place in the Katipiri Sands, which contain the Malkuni fauna. Also collected by Gregory and later expeditions of the University of California and the South Australian Museum, are several localities on the Warburton River, including Green Bluff Locality (UCMP V-5771), Lookout Locality (UCMP V-5776) and Kalamurina. The Warburton River is in the eastern Lake Eyre sub-basin, and has produced fossils from the Katipiri Sands. A Smithsonian Institution-American Museum (SIAM) expedition in 1970 recovered a tarsometatarsal fragment (SIAM 75) of an emu from the Katipiri Sands (Malkuni fauna) at Lake Kittakittaoooloo.

The Smithsonian Institution-American Museum Expedition and later a Museum of Victoria-Australian Army Expedition also recovered a number of *Dromaius* fossils from the lower level of Lake Callabonna in South Australia. This stratigraphic unit producing the emus also contained *Genyornis newtoni*, *Diprotodon optatum*, *Phascolonus gigas*, *Sthenurus*, *Protemnodon*, and *Macropus* (Stirling & Zeitz 1900, Rich 1979) and has been dated at greater than 40 000 B.P. (Tedford 1967), but sometime during the Pleistocene.

An incomplete femur (SAM P17103) bearing the museum label: '?*Genyornis*. Pleistocene locality unknown, possibly Baldina Creek near Burra, South Australia' is actually *Dromaius*. If the location is in fact Baldina Creek, a Pleistocene age is suggested by the occurrence of known *Genyornis newtoni* (Rich 1979) and *Diprotodon* at this site (Stirling & Zeitz 1900).

Several fossils of *Dromaius* were collected near Burra, South Australia by Mr R. E. Ireland and forwarded by the police department on 12 March 1935 to the South Australian Museum. They were found in a sandhill in association with Aboriginal (*Homo sapiens*) bones, SAM A25805 (information from museum label). The Aboriginal remains suggest a Pleistocene to Recent age.

Two caves near Naracoorte (about 320 km SE of Adelaide near the Victorian border), South Australia, have produced *Dromaius*: Victoria Fossil Cave (van Tets & Smith 1974) and Henschke's Bone Dig. Sediments producing the fossils in Henschke's Bone Dig have been radiocarbon dated at about 33 800 B.P. (van Tets 1974). Smith (1971) stated that the bones in Victoria Fossil Cave are most abundant in the top 15 cm of the damp, friable, light brown earth forming the floor of the cave. She also states that the abundance of sthenurines, diprotodontids, and *Thylacoleo* suggests that the deposit was formed sometime during the Pleistocene and sealed before the Recent. Wells *et al.* (1984) provide a complete discussion of current dates from this site.

SYSTEMATICS

Only those features exhibited by the fossil specimens are discussed. For measurements see Table 2.

Family CASUARIIDAE Brisson

Members of the Casuariidae have a pterygoid that is inflated where it contacts the palatine; a palatine with a short shaft and an expanded medial plate; a long vomer; a palate that lies ventral to the parasphenoid rostrum and makes contact with the braincase only at the basiptyergoid processes; maxillopalatines that are cone-shaped and open posteriorly; the cervical vertebrae are antero-posteriorly compressed; the atlas possesses lateral spines or occasionally complete vertebrarterial canals; the sternum is longer than wide with lateral margins concave laterally and has short, dorsally-directed sternocoracoidal processes and no sternal notches; the costal margin forms about 50% of the lateral margin; the antitrochanter of the synsacrum is located at the anteroposterior mid-point of the synsacrum; the ilium, ischium and pubis are subequal in posterior extent; neither the pubes nor the ischia are fused posteriorly along the mid-line; the ischium is deeper than the pubis; the ilium dorsal to the acetabulum is deep; the trochanter and head of the femur are subequal in proximal extent; the external condyle extends only moderately distal to the internal condyle; the popliteal fossa is elliptical and of moderate width; the distal depth and width of the femur are subequal; the posterior margin of the proximal articular surface is highly concave anteriorly; the external condyle and fibular condyle are subequal in breadth or the fibular condyle is broader; the cnemial crests of the tibiotarsus are little compressed mediolaterally; the inner cnemial crest extends far proximally to the proximal articular surface; the external articular surface extends far laterally; the margin of the external condyle is semicircular in lateral view; the tibiotarsus lacks a supratendinal bridge and also lacks an intercondylar eminence; the hypotarsus of the tarsometatarsus is narrow and centrally located; the hypotarsus extends decidedly further proximally than the intercotylar prominence; the internal cotyla is deeper than the external; the posterior shaft surface is deeply grooved; the anterior metatarsal groove is deep and extends the length of the shaft; trochlea IV extends distal to trochlea II; trochlea III extends distal to trochleae II and IV; the phalangeal count for digits II, III, IV is 3-4-5; of the proximal phalanges that of digit III is longest; that of digit IV is shortest; the unguals are generally claw-like, except for the elongated ungual of digit II in *Casuarius*.

Subfamily DROMAIINAE Vieillot

Within the Casuariidae there are a number of characters which reliably distinguish *Dromaius* from *Casuarius*, the only other member of the family. In *Dromaius* the mandible is broad and rounded distally, not narrow and pointed distally; the mandibular articulation of the quadrate is step-shaped, with the external facet decidedly more excavated (in *Casuarius* the facets of the mandibular articulation of the quadrate are subequal); the pterygoid is not excavated dorsally; and the palatine and vomer are decidedly shorter than in *Casuarius*; the semicircular notch in the prearticular surface of the atlas is shallow and narrow, not deep and broad; the axis is longer, and the hypapophysis not as deep as in *Casuarius*; the cervical vertebrae possess long, not short, styloid ribs, which come to a point distally, and are not rounded; the neural canals and vertebrarterial canals are small; the excavation of the neural arch posterior to the prezygapophysis is shallow (from the eighth cervical posteriorly in *Casuarius* the excavation of the neural arch is deep); the thoracic vertebrae are similar to those of *Casuarius*, but the neural canals are smaller; the neural canals of the caudal vertebrae are small, with an elliptical cross-section, whereas in *Casuarius* the neural canals are large and triangular in cross-section; the sternum is only slightly longer than wide, not much longer than wide as in *Casuarius*; the costal processes lie in an almost horizontal plane, whereas in *Casuarius* they lie on a downward curve (antero-posteriorly); the sterno-coracoidal processes are moderately long, not very short as in *Casuarius*; the coracoidal sulci are short and overlap medially, whereas they are long and do not overlap in *Casuarius*; the body of the sternum is weakly concave dorsally, but in *Casuarius* it is strongly concave dorsally; the depth of the sternum anteriorly is shallow, not deep; the costal margin is long, whereas in *Casuarius* it is shorter; the supratrochanteric ridge is broader; the pre-acetabular synsacrum tends to be shorter than the post-acetabular synsacrum in *Dromaius* while the opposite condition exists in *Casuarius*; proximally and posteriorly the femur bears a large pneumatic foramen, lacking in *Casuarius*; in anterior view, the external condyle extends decidedly further proximally than the internal condyle, while the two condyles are subequal in anterior proximal extent in *Casuarius*; in medial view, the internal condyle is semicircular in outline, while in *Casuarius* it is triangular; the diameter of the head and the minimum diameter of the shaft at its proximo-distal mid-point are equal, whereas in *Casuarius* the head diameter is less than the shaft diameter; the shaft is almost straight, being more curved in *Casuarius*; the proximal extent of the cnemial crest is not as great as in *Casuarius*; anteriorly the external

condyle is rounded proximally, and it extends further proximally and is more pointed in *Casuarius*; above the anterior intercondylar fossa is a small ridge trending dorsally and laterally from the mid-line and ending in a small foramen, while in *Casuarius* this ridge is absent, but the foramen still exists; the tarsometatarsus and tibiotarsus are subequal in length, unlike in *Casuarius* in which the tarsometatarsus is decidedly shorter; the second trochlea is much more reduced than in *Casuarius*; the intercotylar prominence is low and tends to be flat, while in *Casuarius* the intercotylar prominence is higher and convex dorsally; a distal foramen, which completely penetrates the tarsometatarsus (antero-posteriorly), and a groove (occasionally a completely roofed-over foramen) running proximodistally, are present, both absent in *Casuarius*; the condyles of the phalanges of the foot tend to be greatly divergent plantarly; in *Casuarius* the condyles tend to be only moderately divergent plantarly; in distal view, the intercondylar fossa tends to be only slightly notched in a step-shaped fashion dorsally, while in *Casuarius* this notch tends to be deeper and more V-shaped; the ungual of digit III is longest, and that of digit IV shortest, while in *Casuarius* the ungual of digit II is longest, and that of digit IV shortest.

Dromaius novaehollandiae (Latham)

Type

Casuarius novaehollandiae (Latham)

Type Locality

New Holland (Sydney, New South Wales, Australia) (Table 1).

Measurements

Tables 2-13.

Referred Fossil Material

Bingara, New South Wales — *V.*, MM F16786, dorsal vertebra (V.24-26?), neural spine, pre- and postzygapophyses, diapophyses and prearticular surface damaged; MM F16797, dorsal vertebra (V.24-26?), neural spine and diapophyses not preserved. *Tib.*, MM F16775, distal end and distal half of shaft. Pleistocene.

Bone Cave (near Jewel Cave), Western Australia — *Tib.*, WAM 68.5.34 (in part), shaft only. *Tmt.*, WAM 68.5.34 (in part), shaft only. Quaternary.

Brothers Island, South Australia — *F.*, SAM P17104, proximal end and proximal two-thirds of shaft, head and trochanter damaged. Quaternary.

Chinchilla, Queensland — *Tmt.*, QM F1143 (in part), third trochlea only.

Cooper Creek, South Australia — *Syn.*, UCMP 56133, acetabular complex, (site 2, UCMP V5378). *F.*, HM B775/869, entire, (Lower Cooper, locality 3). *Tmt.*, UCMP 56313, distal end, fourth

trochlea not preserved, (site 3, UCMP V5379). Late Pliocene or Early Pleistocene.

Darling Downs, Queensland — *F.*, QM F1143 (in part), distal, popliteal fossa region only (eastern Darling Downs). *Tib.*, AM A9713, proximal, see Figure 1; QM F5547, proximal, figured (De Vis 1889); QM F5548, distal, figured (De Vis 1889); QM F1652, proximal end, most of cnemial crest not preserved, (Condamine River, near Dalby). *Tmt.*, QM F1121, proximal frag.; QM F1135, figured (De Vis, 1892), distal, juvenile; QM F1142, distal frag.; QM F1143 (in part), distal end (eastern Darling Downs). Pleistocene.

Lake Callabonna, South Australia — AMNH 9678. *V.*, second cervical, posterior left side; third cervical, left side; fourth cervical (articulates with third cervical), neural spine and ribs not preserved; sixth cervical?, ribs and right side postarticular surface not preserved; seventh cervical?, (articulates with sixth cervical), ribs and right side prezygapophysis not preserved; ninth cervical?, postarticular surface, ribs, right side postzygapophysis not preserved. SIAM 61. *St.*, fragments. AMNH 9677. *F.*, distal end, internal condyle damaged. AMNH 9676. *Tib.*, entire, see Figure 2. Pleistocene.

Lake Kanunka, South Australia — *V.*, UCMP 56855, dorsal vertebra (V.22 or 23), (UCMP 5772). *F.*, UCMP RHT1064, trochanter, condyles, and head partly eroded and crushed, (site 1, UCMP V5772). *Tib.*, UCMP 56845, distal end, most of internal condyle not preserved and remainder highly eroded (UCMP V5772). *Ph.*, UCMP 56849, first phalanx, second digit, (UCMP V5772); UCMP 94679, first phalanx, third digit; UCMP 94680, second phalanx, third digit (UCMP V5772). Late Pliocene or Early Pleistocene.

Lake Menindee, New South Wales — *Eggshell*, UCMP 55948. *Tib.*, UCMP 53825, two distal tibiotarsi with the same number. *Tmt.*, UCMP 53835, distal end most of third trochlea and second and fourth trochleae not preserved. *Ph.*, UCMP 53832, dark colour (presumably burnt), first phalanx, second digit, distal end; ungual phalanx, second or fourth digit; first phalanx, second digit, proximal end; second phalanx, fourth digit (UCMP V5371), UCMP 53833, first phalanx, fourth digit and ungual (site 11, V67185); UCMP 55983, first and second phalanges, third digit (UCMP V67186). Late Pleistocene.

Lancelfield, Victoria — *Tib.*, NMV P43037, distal shaft; NMV P43041, distal shaft, juvenile; NMV P44011, entire but articular surface worn; NMV P150013, distal. *Tmt.*, NMV L5, distal; NMV P44012, proximal articular surface eroded; NMV P44013, hypotarsus eroded; NMV P44014; NMV P44015, proximal articular surface worn, second and fourth trochleae not preserved; NMV P44016,

proximal articular surface worn; NMV P44017, distal shaft; NMV P44018, distal; NMV P44019, distal; NMV P48392, second and part of third trochleae not preserved; NMV P150014, distal, fourth trochlea not preserved. *Ph.*, NMV P43199, first phalanx, third digit, articular surfaces worn; NMV P43200, second phalanx, third digit, proximal end. Late Pleistocene, 26 000 B.P.

McEachern's Cave, Victoria — *C.*, NMV P157345, posterior fragment; NMV P157350, lower jaw, distal; NMV P157353, posterior fragment. *V.*, NMV P157346, 21st or 22nd vertebra, neural spine, diapophysis, right side prezygapophysis, part of centrum and prearticular surface not preserved; NMV P157349, 23rd or 24th vertebra, neural spine, pre- and postzygapophyses not preserved, postarticular surface worn; NMV P157351, seventh cervical?, juvenile, ribs not ankylosed; NMV P157352, 11th, 12th or 13th cervical, juvenile; NMV P157359, third cervical, right side rib not preserved; NMV P157364, 25th or 26th vertebra, left side of centrum with prezygapophysis and diapophysis, but postarticular surface not preserved; NMV P157367, 20th or 21st vertebra, diapophysis, part of neural arch, postzygapophyses, and right side prezygapophysis only, juvenile; NMV P157368, about 11th cervical, prearticular surface worn, left side prezygapophysis and ribs (not ankylosed) not preserved, juvenile; NMV P157369, 22nd to 26th vertebra, right side of centrum only, juvenile. *St.*, NMV P157347, incomplete; NMV P157355, entire. *Syn.*, NMV P157361, fragment. *Tib.*, NMV P157356, proximal; NMV P157357, distal; NMV P157360, distal; NMV P157365, proximal. *Fib.*, NMV P157363, proximal end. *Tmt.*, NMV P157344, distal, trochleae not preserved. Quaternary.

Cave north of Moore River, Western Australia — *Tmt.*, WAM-190 unregistered, (not seen, data from Pat Rich's 1971 field notes). Quaternary.

Naracoorte, (Henschke's Bone Dig and Victoria Fossil Cave), South Australia — *C.*, SAM P17834, lower jaw, distal end only, (Henschke's A3, 40"). *V.*, SAM P17589, 16th cervical, ribs not preserved; SAM P18246, fourth cervical; SAM P18247, 22nd to 24th vertebra, part of centrum and left side diapophysis, (Henschke's); SAM P18673, 15th to 17th cervical? vertebra, prezygapophyses and centrum damaged, (Henschke's area X4, depth 17"); SAM P18830, 26th vertebra, prezygapophyses, prearticular surface and diapophyses damaged, (Henschke's area X6, 15–30 cm). *Syn.*, unregistered SAM; SAM P16501, acetabular complex only, (Victoria Fossil Cave, 0·10·R10-0·12"), see Figure 3; SAM P17767, parts of ilium, ischia and pubes not preserved, (Henschke's A3, 39–42"); SAM P18100, distal right ischium only, (Henschke's A1, 33–36"). *F.*, SAM P22812 (in part), condyles badly eroded; unregistered SAM, internal condyle damaged. *Tib.*,

SAM P17149, distal end, internal condyle worn; SAM P18829, distal, part of condyles not preserved, (Henschke's area X6, 0–15 cm). *Tmt.*, SAM P17816, distal, (Henschke's A1, 30–33"); SAM P18693, 2 pieces, proximal, with articular surface badly eroded, and distal (Henschke's area A4, 150 cm, western wall), *Ph.*, SAM P18059, first phalanx, second digit (Henschke's area A3, 33–36"); SAM P18248, second phalanx, third digit, (Henschke's); SAM P18249, first phalanx, fourth digit, (Henschke's); SAM P18252, first phalanx, fourth digit, (Henschke's). Pleistocene.

Salt Creek, South Australia — *F.*, SAM P17101, proximal shaft only, but head and part of trochanter not preserved. Quaternary.

Thorlindah, (Parnoo River), Queensland — *Tib.*, MMF 12074, figured (Etheridge 1889), a cast (AM L516) has been made, distal end, condyles worn. Pleistocene.

Trogdip Cave, Buchan Caves, Victoria — *Tmt.*, NMV P157343, shaft only. Pleistocene.

Warburton River, South Australia — *V.*, UCMP 56642, 21st or 22nd vertebra, centrum only (Green Bluff locality, UCMP V-5775). *Syn.*, UCMP 56647, fragment, fused sacral vertebrae only. *F.*, HM B801/934, distal, most of internal condyle not preserved, (Kalamurina), see Figure 4. *Tmt.*, SAM P13118, distal end, second trochlea not preserved. (Stony crossing of Warburton, Six road miles west of new Kalamurina Station.) Quaternary.

Wellington Caves, New South Wales — *Tib.*, AM 'B', distal end, external condyle missing; AM F10949, distal half, (J. Mahoney, in a note on the back of the museum label, disputes this locality). *Tmt.*, unregistered AM, proximal articular surface badly worn; AM 'C', proximal; AM F18935, distal end and part of shaft, second trochlea not preserved, other trochlea pitted, no distal foramen, juvenile; AM MF771, distal. Quaternary.

Wombeyan Quarry, New South Wales — *Tib.*, AM P58025, distal end and distal one-third of shaft. *Tmt.*, AM P58026, proximal. Late Pleistocene.

Comments and Description

Dromaius novaehollandiae is the only extant species. A number of subspecies have been suggested (Condon 1975), but little is known of their ranges or morphological distinctness. The osteological characteristics of the species have been described above. There is a suggestion that a slightly smaller, as well as a larger form of *Dromaius novaehollandiae* existed during the Pleistocene. The name *gracilipes* proposed by De Vis for the smaller form was applied to a juvenile *D. novaehollandiae* (see below). Hence the smaller form, if real, is yet unnamed. As the evidence is limited, we have chosen not to create a separate specific or subspecific names. De Vis also described a larger

species of emu, *D. patricius*, which we have also synonymized with *D. novaehollandiae* (see below).

Dromaius patricius (De Vis)

Lectotype (here designated)

QM F5547, proximal right tibiotarsus, King Creek, Darling Downs, south-eastern Queensland, Pleistocene.

Measurements

Tables 9 and 11.

Referred Material

De Vis assigned a coracoid, and a proximal and a distal tibiotarsus to this species without naming a type specimen. The left coracoid, QM F1120, was only provisionally referred to *patricius* (De Vis 1888: 1291). In actual fact it is not even a bird bone. The bone is not hollow, and it projects too far lateral to the point taken by De Vis for the glenoid facet to conform with an emu coracoid. Additionally, it lacks a pneumatic foramen. It is too large, heavy, and robust to match any bird. It is probably part of a mammalian pelvis.

The distal end of the left (not right as De Vis states) tibiotarsus, QM F5548, which De Vis assigned to *D. patricius* is not distinguishable from *D. novaehollandiae*. De Vis also stated (p. 1290) that: 'the rotular surface is relatively longer fore and aft to a considerable extent and less concave transversely', but he admitted (p. 1291) that (this: 'is perhaps in some measure due to abrasion'). The difference in the 'eminences and ridges for muscle insertions' anteriorly are also as De Vis states (p. 1291): 'scarcely of specific value'. This specimen is within the size range of *D. novaehollandiae*.

Hence we designate the proximal right tibiotarsus, QM F5547, as the lectotype of *Dromaius patricius*. It is in most respects trivially different, if at all from *D. novaehollandiae*. The proximal width (of the articular surface) is greater than any *D. novaehollandiae* in our sample (57.6 mm vs a maximum of 55.6 mm for *novaehollandiae*, sample size, $n=9$). The inner cnemial crest (>90.2 mm) is unfortunately not entirely preserved. It may have exceeded the maximum of our sample of *D. novaehollandiae* (103.1 mm). Concerning other points raised by De Vis, the fibular crest does not attach more proximally, but the bone is thicker at the most proximal point of this crest, the external cnemial crest does descend more distally and a groove between the external and internal cnemial crests does exist that is larger than is present in *D. novaehollandiae*. We feel that the variability exhibited by *D. patricius* would not fall outside that of a large sample of the living emu.

De Vis (1905) also referred a synsacral fragment (consisting of the neural canal of several synsacral vertebrae), QM F5549, to *D. patricius*, though it is

so incomplete as to render diagnosis difficult. It is within the size range of *D. novaehollandiae* and probably could be referred to that species. We have, however, chosen to assign it only to Casuariidae indeterminate. It was collected from Wurdulmankula, a Cooper Creek locality.

De Vis (1892) referred a part of a distal end of a femur (likely to be QM F1143, in part), the proximal third of a tarsometatarsus (likely QM F1121), the 'calcaneal region of another metatarsus' (apparently lost subsequently) and a distal tarsometatarsus (likely QM F1143 in part) to *D. patricius*. As De Vis did not figure or describe these specimens in any detail, we are assuming that the QM specimens listed are those referred to in his 1892 paper. They agree with the (limited) description, were collected in the Darling Downs according to the museum labels accompanying the specimens, and appear to bear (on the fossils themselves) De Vis' handwriting. Of these, only the distal tarsometatarsus is described. It is stated to be larger in almost all of its dimensions than the living Emu. It is, indeed, wider than any in our small sample both in the shaft and in its trochlear expansion, and trochlea 3 is deeper than those in our sample of *D. novaehollandiae*. The proximal tarsometatarsus is very worn; it lacks both the internal and external cotyla, the intercotylar region, and the hypotarsus. It is within the size range of the living *D. novaehollandiae*. The femur is also very fragmentary; only the popliteal region is preserved, and it, too, lies within the range of *D. novaehollandiae*.

Etheridge (1889) referred a distal right tibiotarsus, MM F12074 (and cast AM L516) to *D. patricius*, but contrary to his assertion, the specimen is not larger than nor of a different shape to that element in the modern emu. It should be referred to *D. novaehollandiae*.

Thus, some of the specimens that have been considered to be *D. patricius* are indistinguishable from *D. novaehollandiae*. Others may be slightly larger in some measurements, but we doubt that *D. patricius* deserves, on that account, specific status, because our sample of the living emu is still small. We, therefore, synonymize *D. patricius* with *D. novaehollandiae*.

Dromaius gracilipes (De Vis)

Holotype

Tmt. QM F1142, Darling Downs, Queensland, Pleistocene.

Measurements

Tables 10 and 11.

Description

De Vis based this species on a distal left tarsometatarsus, QM F1142, with the second and

fourth trochleae not preserved and the margins of the third trochlea very eroded. The characteristics which De Vis used to distinguish this from *D. novaehollandiae* are the lack of a distal foramen and associated muscle canal, inferior size of the distal end, antero-posterior compression of the shaft, and disproportionate size of the mesial trochlea. These are all juvenile characteristics. De Vis also states that the width of the third trochlea taken from centre of the lateral depressions (i.e. the ligamental pits) is greater in *D. gracilipes* than in *D. novaehollandiae*. This is not the case. We therefore synonymize *D. gracilipes* with *D. novaehollandiae*.

Metapteryx bifrons (De Vis)

Type

Tmt. QM F1135, locality not given, but presumably Darling Downs, Queensland, Pleistocene.

Measurements

Table 11.

Description

De Vis erected this genus and species on the basis of a left distal tarsometatarsus, QM F1135, and allied it with the kiwis because: 'the trochlea appear to be borne on the ends of moderately long stalks' (De Vis 1892: 449), the lateral trochlear processes (i.e. the second and fourth trochleae) are almost equal in length, the medial trochlea extends beyond the others, the posterior surface of the shaft shows the lines of junction between the coalesced segments, and it lacks a distal foramen which perforates the shaft. De Vis considered the possibility that these might be juvenile characteristics, but unfortunately dismissed this idea. De Vis was of the opinion that the fourth trochlea was shorter (that it was a right tarsometatarsus), but actually the second trochlea is shorter. The comparatively large intertrochlear notches, the rough pitted caps on the trochleae, and the points raised by De Vis (presence of epiphyseal lines, lack of distal foramen) are indications that the specimen is of a juvenile bird. As De Vis himself noted, the fossil does not have any articulation for the hallux possessed by kiwis, and the middle trochlea is too large for that of a kiwi. *Metapteryx bifrons* in all respects conforms to a juvenile individual of *D. novaehollandiae*, and we synonymize it with that species.

Dromaius ocypus (Miller)

Holotype

Tmt. SAM P13444, Lawson-Daily Quarry, Lake Palankarinna, eastern Lake Eyre Basin, South Australia, Mampurwordu Sands, Palankarinna fauna, Pliocene.

Measurements

Tables 8, 9, 10 and 11.

Referred Material

F. UCMP RAS5176, condyles, trochanter, and most of head not preserved. *Tib.* UCMP RAS5182, distal. Same locality as type.

Description

Miller (1963) established this species from an essentially complete, but somewhat distorted and cracked right tarsometatarsus, SAM P13444. The overall length, width across the distal end, depth across the internal cotyla and proximal width are all less than similar measurements in living and fossil *D. novaehollandiae*. Additionally, the curvature of the intercotylar region is more pronounced (convex dorsally) than in *D. novaehollandiae*. As noted by Miller (1963), the trochleae have already attained the size and proportions of *D. novaehollandiae*. The width across the distal end is smaller, in part because the intertrochlear notches are narrower than in *D. novaehollandiae*.

The femur and tibiotarsus are provisionally assigned to *D. ocypus*, although they lie within the range of *D. novaehollandiae* in those parts which are preserved, because they were found in the locality of the type specimen. The tarsometatarsus of *D. ocypus* differs most noticeably from *D. novaehollandiae* in its shortness. Unfortunately, the referred specimens are incomplete, and their length cannot be ascertained.

Dromaius gidju n. sp.

Holotype

SAM P26779. Associated left leg elements.

Type locality

Leaf locality (UCMP V6213), Lake Ngapakaldi, eastern Lake Eyre Basin, South Australia, Wipajiri Fm. Kutjamarpu fauna. Medial Miocene.

Description

An incomplete left leg, consisting of the distal fragment of the tibiotarsus (originally UCMP 71397), the proximal part of the tarsometatarsus (originally UCMP 71398), and a complete pes (originally UCMP RAS5234). The tibiotarsal fragment articulates with the tarsometatarsal fragment. The pes is complete but does not articulate with the tarsometatarsal fragment as the trochleae of the tarsometatarsus are not preserved. All fragments were found in close proximity and the assumption is made here that they are from one individual. Dr R.A. Stirton in his field notes of 19 July 1962 assumed that the leg and foot elements were all from one individual and assigned them a single field number RAS 5234.

Etymology

From an Aboriginal word meaning 'small' (Anonymous 1965, language not specified).

Measurements

Tables 9, 10 and 12.

Referred material

None.

Diagnosis

A small emu with a slender antero-posteriorly compressed tibiotarsus and tarsometatarsus. The anterior lip of the intercotylar region is convex dorsally in *D. gidju* (as in *D. ocybus* compared to nearly flat in *D. novaehollandiae*). The intercotylar region does not extend far proximal to the articular surface as it does in *Casuarinus*, however. The lateral lip of the external cotyla is noticeably convex laterally in *D. gidju* (weakly so in *D. novaehollandiae*). The width and depth of the proximal articular surface are much less than in *D. ocybus* and *D. novaehollandiae*. The *D. gidju* tibiotarsus is much smaller than those in our *D. novaehollandiae* sample, but is similar in general appearance and proportions of the distal end. Anteriorly the tarsometatarsus proximal to the condyles is somewhat crushed. The external ligamental prominence above the external ligamental pit is not as well defined in *D. gidju* as it is in *D. novaehollandiae*. The anterior ligamental fossa appears proportionally larger and deeper than in *D. novaehollandiae*. The phalanges (except the second phalanx of the second digit) are smaller than those in *D. novaehollandiae*. Digit II is comparatively longer relative to the other digits than in *D. novaehollandiae* (64% of the length of digit III versus 57.5–60.5% for our sample of *D. novaehollandiae* (see Tables 2 and 12); the first phalanx of digit II is 85% of the proximal depth of the first phalanx of digit III versus 76.5–78% for our sample of *D. novaehollandiae*, and 66% of the proximal width of digit III versus 52–53% for our sample of *D. novaehollandiae*). Digit IV is also comparatively longer but less change has occurred (68% of the length of digit III versus 62–64% for our sample of *D. novaehollandiae*, the first phalanx of digit IV is 78% of the depth of the first phalanx digit III versus 73–75% in our sample of *D. novaehollandiae*). Excepting the proximal phalanges, the ratio of maximum proximal depth to width is greater in *D. gidju*; thus, the phalanges of *D. novaehollandiae* are more dorso-ventrally compressed than in *D. gidju*. The ungual phalanx of digit II in *D. gidju* is longer than the ungual of digit III (which is poorly preserved). This is not due to an elongation of the ungual of digit II in *D. gidju*, as in *Casuarinus*, but the weak development of the digit III ungual.

Comment

From what is known of its hind limb structure, it would appear that *D. gidju* was less cursorially adapted than *D. novaehollandiae*. This is based on the greater length of digits II and IV relative to digit III in *D. gidju* as compared to *D. novaehollandiae*. This foot structure is presumably adapted for greater maneuverability in forested or less open conditions and greater ability to move over regions of a somewhat unpredictable nature.

***Dromaius* sp. indet.**

Several specimens because of their fragmentary nature and/or unusual proportions could not be assigned to species level. Other specimens were referable only to Casuaridae indet. (see following section).

Referred Material

Tables 3–12.

No Locality Data — *Tmt.*, AM F58087, distal end, trochleae not preserved.

Alcoota, Northern Territory — *Tmt.*, QM QA205, third trochlea only; QM QA505, distal, fourth trochlea not preserved. UCMP RAS5397 (in part), a third trochlea only. *Ph.*, QM QA504, first phalanx, third digit; UCMP RAS 5397 (in part), second phalanx, second digit. The Alcoota specimens are close to *D. gidju*. Late Miocene.

Baldina Creek? (near Burns), South Australia — *F.*, SAM P17103, shaft only, partially reconstituted in plaster. Quaternary.

Cooper Creek, South Australia — *Tmt.*, QM F1121, proximal, badly eroded articular surface. Could be Pliocene–Recent in age.

Lancefield, Victoria — *Tmt.*, NMV P35578, distal shaft, Pleistocene in age, dated at about 26 000 B.P. (Gillespie *et al.* 1978).

Warburton River, South Australia — *Tb.*, QM F6668, distal, condyles not preserved, ('Kalamurina?' is pencilled on the bone). *Tmt.*, QM F6671, proximal, incomplete fusion of metatarsals dorsally, tarsal cap not preserved, juvenile. Pleistocene–Recent in age.

Wellington Caves, New South Wales — *St.*, AM F25218, figured (Anderson, 1934), incomplete. *Tmt.*, AM 'A' distal, trochleae not preserved; AM F10850 (cf. *D. novaehollandiae*), proximal end plus proximal part of shaft, articular surface eroded. Pleistocene.

Dromaiinae* indet.*Referred Material**

Tables 3–12.

No Location Data — *Syn.*, QM F6673, fragment, fused vertebrae only.

Bingara, New South Wales — *Syn.*, MM F16795, fused vertebrae only. Pleistocene.

Cooper Creek, South Australia — *V.*, HM B776, dorsal vertebra, 24th–26th?, centrum and left postzygapophysis only, (Lower Cooper, locality 2). *F.*, HM B777, part of a left internal condyle and internal popliteal fossa region only; UCMP 60532, popliteal fossa region only, (Karipiri Waterhole, UCMP site 9, V-5861). The locality suggests all specimens are *Dromaius* sp. Pleistocene.

Lake Kanunka, South Australia — *V. r.*, UCMP 60560, third or fourth vertebrae?, proximal (dorsal) only, (Site 1, UCMP V-5772). Probably *Dromaius*; other *Dromaius* elements known here. Probably Late Pliocene, possibly Pleistocene.

Lake Kittakittakooloo, South Australia — *Tmt.*, SIAM 75, fourth trochlea only, pitted, juvenile. Late Pliocene, possibly Pleistocene.

McEachern's Cave, Victoria — *V. r.*, NMV P157354, dorsal fragment; NMV P157358, dorsal fragment; NMV P157362, dorsal fragment; NMV P157366, dorsal fragment, one facet not preserved. Probably *Dromaius*. Quaternary.

Naracoorte, South Australia — *V. r.*, SAM P18107, third vertebrae?, dorsal fragment, (Henschke's Bone Dig); SAM P18251, dorsal fragment only but facets not preserved, (Henschke's Bone Dig); SAM P18784, third vertebrae?, dorsal fragment (Henschke's Bone Dig); SAM P22812 (in part), third or fourth vertebrae?, dorsal fragment. The locality suggests these specimens are *Dromaius*. Quaternary, probably Late Pleistocene.

Warburton River, South Australia — *Syn.*, UCMP 56647, acetabulum and peclineal process only. Quaternary.

Wombeyan Quarry, New South Wales — *Tib.*, AM P58027, cf. *Dromaius*, distal end. Late Pleistocene.

Aves indet.

(previously assigned to *Dromaius*)

Referred Material

Tables 10 and 11.

Kalamurina, South Australia — *Tmt.*, SAM P11552, distal end, second trochlea not preserved, large. Perhaps *Dromornithidae* (Table 11). Quaternary.

No Locality Data — *Tib.*, SAM P17148, proximal shaft only; articular surface and cnemial crests not preserved. Possibly not avian — the bone is rather dense.

Dromaius ater and *D. baudinianus* are not reviewed here as Parker (1984) has recently revised their taxonomy.

DISCUSSION

At least one species of emu, *D. gidju*, was present in central Australia in the mid-Miocene. It is known from the Lake Ngapakaldi in northern South Australia and associated with the Kutjamarpu fauna. It does not differ sufficiently from other emus to require erection of a new genus. While the intercotylar region of the fossil tarsometatarsus resembles the condition found in *Casuaris* in that it is not markedly flattened as in the living *Dromaius*, this character state is also true of *D. ocybus*, an undoubted emu from the Pliocene. The shape of the margin of the internal cotyla of the fossil is similar to that of *Dromaius* and dissimilar to that of *Casuaris*, which is more excavated posteriorly. The posterior surface of the tarsometatarsus of *D. gidju* is unfortunately chipped and cracked, but the shape of the remaining fragment of the hypotarsus and tarsal cap appears more emu-like than cassowary-like. Comparing the pes of the Miocene fossil with recent emus it is obvious that the foot structure has undergone change through the last few million years. The second and, to a lesser extent, the fourth toes have undergone a reduction in size. This trend is parallel with several other ratites (the ostrich and some of the *Dromornithidae*; Rich 1979), and would appear to be a cursorial adaptation similar to the reduction and eventual loss of lateral and medial digits within horses (*Equidae*). The pes of *D. gidju* is more cassowary-like than that of any known living or other fossil emus, implying that in the Miocene, emus were not as highly adapted to an open plains, cursorial lifestyle as they are now. The pes does not, however, contain the specialized ungual spike on digit II, which so characterizes the cassowaries. *D. gidju* appears to be a species that may be close to forms which gave rise to both emus and cassowaries. Based on material now available, *D. gidju* has a few specialized characteristics that seem to ally it with *Dromaius*. But, as our records of this form increase, there may be sufficient reason to separate it from both genera within this family as an early, quite unspecialized form.

A small emu of Miocene age, is also known from Riversleigh, Queensland. This material is currently under study by Walter Boles (Australian Museum). By Late Miocene or Early Pliocene times a species near in size to *D. gidju* is known in the Alcoota fauna. It is represented by tarsometatarsal and pedal fragments. This form may be referable to *D. gidju*. The two phalanges differ slightly from those of the Lake Ngapakaldi form, which we have referred to *D. gidju*, but are within the range expected for intraspecific variation. Until more complete material is available from Alcoota, however, assignment to *Dromaius* sp. indet. is preferable. It

is certainly not referable to *Casuaris*, as the second trochlea is much more reduced relative to the other trochleae, similar to the condition in *Dromaius*.

By mid-Pliocene, a second species of emu, *D. ocybus* Miller, intermediate in size between *D. gidju* and *D. novaehollandiae*, existed. It is known from a right tarsometatarsus and part of a femur and tibiotarsus. The femur and tibiotarsus are, in those parts which are preserved, not unlike *D. novaehollandiae*, but if complete would probably be shorter than the corresponding elements in *D. novaehollandiae*.

In any event, *D. novaehollandiae* existed by the Late Pliocene or Early Pleistocene. Since then only *D. novaehollandiae* has been present on the mainland. It has probably fluctuated slightly in size, presumably as a result of a host of selection pressures such as climate (both temperature and rainfall), diet, predation pressure and competition.

The species restricted in Recent times to King Island and now extinct may possibly extend into the Pleistocene. Localities on King Island are as yet not carefully dated. The emus of King Island (*D. minor*) and Kangaroo Island (*D. baudinianus*) appear to be separate species (Parker 1984). The populations on both of these are most likely relicts isolated by rising sea levels at the end of the last glaciation of a population that perhaps was once more widespread. Other than their smaller size the King and Kangaroo Island emus differ but little from the mainland emu. The main osteological difference is in the shape of the skull (Spencer & Kershaw 1910, Morgan & Sutton 1928). Possibly also the distal foramen of the tarsometatarsus differs (Shane Parker pers. comm.), but there is considerable variability in this character in the mainland emu. The degree to which the groove for the musculus adductor digiti IV is roofed over by bone would appear to be age related. In juvenile emus the arch is almost completely lacking, whereas in some adult specimens it is completely formed in bone. Thus, this character is not taxonomically significant for emus. Some Australian mainland fossil emus are within or just larger than the size range for *D. minor* tabulated in Rich (1979). At Lake Menindee, two distal tibiotarsi (UCMP 53825, includes RHT6 and RHT25) lie within the range of *D. minor* for the width across the condyles and depth of external condyle but exceed *D. minor* in the depth of the internal condyle — both specimens measure 37.0 mm in depth of the internal condyle; the range of a sample of 50 *D. minor* was 26.2–36.1 mm, the mean was 30.4 (Rich 1979, Table 33). What the relationship of these fossils is to *D. minor* is unresolved and will remain so until a much larger fossil sample of mainland birds is at hand.

De Vis (1892) did describe a smaller mainland

Pleistocene species, *D. gracillipes*, but his type specimen is undoubtedly an immature *D. novae-hollandiae*. Nevertheless, smaller emus did exist in Australia in the Pleistocene. Of specimens listed in the systematics section (above) the following lie below the range for modern emu in one or more measurements: AM — unregistered tarsometatarsus, 'A', FI0949, MF771; HM B775/869; QM FI121; SAM — PI3118, PI8099; UCMP — 53825, 53832, 55983, 60532, 79510, RHT1064.

The presently known fossils of mainland emu smaller than the living *D. novaehollandiae* are unfortunately few. We do not believe that they are representatives of *D. minor* or *D. baudinianus*, because of the age of the fossils on the islands is Late Quaternary. We favour the idea that speciation on King and Kangaroo Island could have taken place in very little time geologically speaking. Strong selection for dwarfism quite likely occurred after these emus became isolated at the beginning of the last interglacial (i.e. the Holocene).

The mainland emu, *D. novaehollandiae*, may have been at any one time in the Pleistocene both larger or smaller than at present. However, there is a possibility that the differences seen in fossil samples are more apparent than real, since the sample size of modern emu is still fairly small and some of the emus in osteological collections were recovered from zoological gardens. Whether or not extant wild emu populations differed significantly in size is largely unknown. As our sample did not contain representatives from the Northern Territory or Western Australia, it is also unavoidably biased geographically.

Periodic dwarfing of the mainland form may have been caused by the same selective agents which produced dwarfing in the island forms. We were unable to test the hypothesis that size changes were related to palaeoclimate or other environmental variables because there are too few reliably dated emu specimens in the Quaternary collections.

De Vis recognized *D. patricius* as a separate, larger species of emu, but we can see no significant size difference from *D. novaehollandiae*. Perhaps *D. patricius* differed in its proportions from *D. novaehollandiae*. As so few complete bones are known, however, this is difficult to assess. For example, a tibiotarsus SIAM 61 was found to have a smaller length to distal width ratio than most modern emus, but this difference did not prove statistically significant ($p > 0.05$, t-test).

There was a mass extinction of the Australian megafauna [the larger macropodids, diprotodontids, dromornithids, etc. just before the Holocene (Tedford 1967, Gillespie *et al.* 1978)] suggesting a widely acting selective agent against large size.

There is a suggestion that the Tasmanian emu,

D. diemenensis, averaged slightly smaller than the mainland form. This idea stemmed from the known eggs of the Tasmanian emu measuring slightly smaller than those of the mainland emu (DOVE 1926), and from the recollections of Legge (1907), who saw the Tasmanian emu as a boy. On the other hand, Spencer & Kershaw (1910) report that the Rev. Knopwood captured an 'Emew 60 lbs. weight' on 9 October 1804 in Tasmania. Scott (1924) gives the dimensions of a leg of the Tasmanian emu collected by Gunn in the 19th century; it is as large as those of the mainland. The fossils of the Tasmanian emu are large (Scott, 1924, 1932) indicating that the larger Pleistocene form of the mainland also reached Tasmania, presumably at a time when Bass Strait did not exist — during a glacial period of lowered sealevel. Concerning the extinct Recent Tasmanian emu, the best evidence supports the view that it was about the same size as the mainland emu. Condon (1975), following Ridpath & Moreau (1966), treated the Tasmanian emu as a subspecies of *D. novaehollandiae*. Kathryn Medlock (Tasmanian Museum) is currently reviewing the status of this form.

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TABLE 2. Statistical summaries of the extant emu *Dromaius novaehollandiae* (\bar{x} , mean; s, standard deviation; n, sample size).

	Range (mm)	\bar{x}	s	n
<i>Skull</i>				
Length	140-165	154	6.3	16
Width	58.7-76.5	68.4	4.1	21
Depth	44.7-50.7	48.0	1.6	19
Diameter of Foramen Magnum	9.3-13.1	11.0	1.0	25
Length of Lower Jaw	131-155	145	6.5	21
Symphysial Length of Lower Jaw	16.4-23.0	21.0	2.4	23
<i>Sternum</i>				
Maximum Length	114-164	143	11.4	25
Maximum Width	104-141	125	8.2	25
Number of Costal Processes	3-5	4	0.49	28
Width of First Costal Process	98.7-134	116	8.2	24
Width of Last Costal Process	76.4-112.5	96.8	8.2	24
Length of Costal Margin	42.4-66.9	56.0	7.2	24
Length of Sternocoracoidal Process	16.3-44.7	33.3	8.2	24
Width of Coracoidal Sulci	40.2-62.2	51.9	5.9	24
Anterior Depth	14.4-20.4	16.7	2.0	23
<i>Scapulocoracoid</i>				
Proximal Width	38.9-55.6	45.9	4.9	20
Maximum Length	151-187	168	11.3	18
Scapular Length	98.4-127	114	8.7	18
Minimum Width of Coracoid	13.1-22.0	16.1	2.2	20
Minimum Width of Scapula	5.9-8.9	7.3	1.0	19
<i>Clavicles</i>				
Length	35.2-53.3	44.0	5.1	12
Maximum Width	3.6-8.1	5.5	1.2	12
Depth	2.0-4.9	3.4	0.8	12
<i>Humerus</i>				
Length	83.1-98.7	90.3	4.2	20
Proximal Width	5.4-8.3	6.4	0.8	20
Proximal Depth	6.2-7.9	6.9	0.5	20
<i>Ulna</i>				
Length	57.5-73.0	64.9	4.5	20
Proximal Width	3.6-4.8	4.2	0.3	20
Proximal Depth	3.3-4.8	4.0	0.4	20
<i>Radius</i>				
Length	55.2-68.9	63.1	4.1	20
<i>Carpometacarpus</i>				
Length	36.6-50.6	43.6	3.6	20
Proximal Width	7.7-12.3	10.0	1.2	20
Proximal Depth	4.6-6.5	5.5	0.5	20
Distal Depth	2.5-4.4	3.4	0.5	19
<i>Manus</i>				
P1, Length	10.0-26.6	13.6	4.1	13
P1, Proximal Diameter	4.2-6.9	5.0	0.8	11
P2, Length	4.8-8.0	6.3	1.4	5
P2, Proximal Diameter	1.9-3.7	3.0	0.7	5
P3, Length	6.1-14.9	10.4	2.7	6
P3, Proximal Diameter	14.0-5.2	2.8	1.3	6

	Range (mm)	\bar{x}	s	n
<i>Synsacrum</i>				
Length	337–412	378	24.7	17
Diameter of Acetabular Foramen	12.3–21.0	17.3	2.3	23
Width across Antitrochanter	90.9–109	101	5.3	22
Maximum Depth	88.7–109.2	99.3	4.2	23
<i>Femur</i>				
Length	175–218	203	10.1	22
Proximal Width	62.0–68.0	64.9	2.0	10
Proximal Depth (Trochanter)	55.8–63.4	59.7	2.5	10
Diameter of Head	23.5–29.7	26.4	1.5	26
Distal Width	65.4–79.2	71.7	3.2	26
Depth of External Condyle	64.0–75.4	69.3	2.9	26
<i>Tibiotarsus</i>				
Length	340–432	401	21.8	18
Diameter of Shaft, Minimum	19.5–27.0	23.1	1.8	23
Diameter of Shaft, Maximum	24.6–34.2	28.1	2.2	23
Proximal Depth	86.2–103	96.2	5.6	9
Proximal Width	47.4–55.6	52.4	2.8	9
Length of Fibular Crest	74.6–110	90.4	12.1	9
Depth, Internal Condyle	38.7–47.4	42.7	2.8	9
Depth, External Condyle	36.5–45.9	41.8	2.1	26
Width, Distal End	38.9–49.1	45.9	2.2	25
<i>Fibula</i>				
Length	231–305	272	20.9	12
Proximal Width	13.9–19.0	17.1	1.5	22
Proximal Depth	35.2–48.7	38.7	3.0	22
<i>Tarsometatarsus</i>				
Length	332–422	383	18.0	22
Minimum Diameter of Shaft	11.6–17.3	14.7	1.5	23
Maximum Diameter of Shaft	16.8–23.1	19.9	1.5	23
Proximal Width	47.2–54.0	50.0	2.1	25
Depth of Internal Cotyla	25.4–27.6	26.6	0.8	9
Depth of External Cotyla	19.9–23.7	22.0	1.2	9
Depth of Hypotarsus	36.0–41.3	38.5	1.7	8
Distal Width	47.4–54.6	51.1	2.0	8
<i>Tarsometatarsus, trochleae</i>				
Width T2	9.0–11.1	10.0	0.8	9
Width T3	21.9–28.9	24.9	2.0	24
Width T4	12.2–14.9	13.6	1.0	9
Depth T2	13.0–17.6	15.4	1.4	9
Depth T3	19.0–24.3	22.2	1.8	9
Depth T4	14.3–17.2	15.6	1.0	9
<i>Pes</i>				
DII P1 Length	40.7–52.8	47.4	2.8	14
Proximal Depth	16.3–21.4	18.5	1.7	15
Proximal Width	13.2–16.4	14.8	0.8	15
DII P2 Length	17.1–22.4	19.5	2.1	13
Proximal Depth	11.6–13.3	12.3	0.6	13
Proximal Width	12.4–15.6	14.0	1.0	13
DII P3 Length	21.4–28.2	25.9	2.2	9
Proximal Depth	9.4–12.2	11.0	0.8	10
Proximal Width	10.4–12.9	11.5	0.9	10
DIII P1 Length	58.1–65.7	60.5	1.9	14
Proximal Depth	21.3–27.3	23.6	1.5	15
Proximal Width	25.3–31.1	27.5	2.0	15
DIII P2 Length	33.4–42.8	38.8	2.3	13
Proximal Depth	15.0–18.9	16.9	0.9	15
Proximal Width	20.3–25.4	22.5	1.6	14

	Range (mm)	\bar{x}	s	n
DIII P3 Length	19.5 - 29.3	23.6	2.8	12
Proximal Depth	12.1- 14.1	13.1	0.7	13
Proximal Width	17.2- 20.8	19.0	0.9	13
DIII P4 Length	26.7- 34.4	30.4	2.1	9
Proximal Depth	11.7- 14.9	12.9	1.0	11
Proximal Width	14.8- 17.7	15.6	0.9	11
DIV P1 Length	33.7- 41.2	38.5	2.0	14
Proximal Depth	16.0- 19.8	17.3	0.8	15
Proximal Width	16.0- 19.2	18.0	0.8	15
DIV P2 Length	14.9- 18.2	17.0	1.0	13
Proximal Depth	11.1- 13.2	12.5	0.6	13
Proximal Width	14.2- 16.0	15.1	0.5	13
DIV P3 Length	10.5- 14.4	12.0	1.1	11
Proximal Depth	9.9- 12.1	11.0	0.6	12
Proximal Width	12.5- 14.9	13.2	0.6	12
DIV P4 Length	6.4- 12.3	9.7	1.6	11
Proximal Depth	8.7- 10.7	10.1	0.6	11
Proximal Width	10.4- 13.4	12.0	0.8	11
DIV P5 Length	19.2- 24.3	22.2	1.6	8
Proximal Depth	9.3- 11.8	10.5	0.7	10
Proximal Width	10.1- 11.5	10.9	0.5	10
<i>Vertebrae</i>				
C1 Length, Ventral	5.0- 7.9	6.1	0.8	12
Depth of Hypopophysis	5.3- 6.1	5.8	0.3	11
Maximum Width across Arch	12.8- 16.5	14.5	1.4	9
Depth	14.9- 17.7	16.1	0.8	12
Prearticular Surface	6.2- 8.5	7.1	0.7	12
Postarticular Surface	9.0- 11.3	10.4	0.8	10
Dorsal Length	5.8- 7.3	6.4	0.5	10
C2 Depth	25.7- 30.9	28.1	1.4	16
Width across Postzygapophyses	20.4- 24.9	22.3	1.3	16
Width across Diapophyses	12.2- 15.5	13.8	1.0	16
Width across Postarticular surface	6.3- 8.7	7.3	0.7	16
Width across Prearticular surface	9.7- 11.4	10.5	0.5	14
Centrum Length	15.9- 20.5	18.3	1.5	15
Length from Pre- to Post Zygapophyses	14.1- 17.9	16.6	1.1	12
C3 Depth	21.0- 26.1	23.7	1.3	15
Postzygapophyses	22.7- 28.2	25.4	1.4	16
Diapophyses	17.7- 23.5	21.0	1.4	15
Postarticular Surface	6.9- 9.6	8.4	0.7	16
Prearticular Surface	8.1- 10.9	9.1	0.8	16
Centrum length	16.5- 21.2	18.9	1.4	16
Pre-postzygapophyses	22.3- 27.8	29.8	1.7	16
C4 Depth	18.1- 22.6	20.2	1.3	16
Postzygapophyses	22.1- 26.4	24.5	1.3	16
Diapophyses	21.6- 26.8	23.6	1.3	16
Postarticular Surface	9.5- 13.0	11.3	1.2	16
Prearticular Surface	7.9- 12.0	10.3	0.9	16
Centrum Length	20.5- 25.3	22.7	1.6	16
Pre-postzygapophyses	26.4- 32.3	29.4	1.9	16
C5 Depth	14.9- 19.3	17.1	1.2	17
Postzygapophyses	12.8- 19.5	17.0	1.6	17
Diapophyses	25.0- 28.6	26.2	1.1	17
Postarticular Surface	13.6- 19.7	16.0	1.6	17
Prearticular Surface	10.5- 15.7	13.3	1.6	17
Centrum Length	22.4- 26.7	25.2	1.3	17
Pre-postzygapophyses	30.8- 40.6	36.0	2.5	17
C6 Depth	13.9- 19.7	16.5	1.3	17
Postzygapophyses	11.6- 16.4	13.6	1.2	17

	Range (mm)	\bar{x}	s	n
Diapophyses	17.4– 31.1	27.8	3.1	17
Postarticular Surface	16.8– 20.6	18.7	1.3	17
Prearticular Surface	14.5– 19.9	17.4	1.7	17
Centrum Length	25.3– 29.4	27.8	1.3	17
Pre-postzygapophyses	35.7– 42.2	38.8	1.8	17
C7 Depth	15.0– 19.0	16.9	1.2	17
Postzygapophyses	11.5– 17.9	14.0	1.8	17
Diapophyses	27.8– 32.9	30.4	1.7	17
Postarticular Surface	15.2– 20.1	18.0	1.6	17
Prearticular Surface	18.9– 24.1	21.0	1.4	17
Centrum Length	28.5– 32.3	30.7	1.3	17
Pre-postzygapophyses	35.7– 41.4	38.4	1.5	17
C8 Depth	16.2– 19.9	18.0	1.1	17
Postzygapophyses	12.1– 19.7	16.8	2.2	17
Diapophyses	18.4– 34.2	30.4	3.6	17
Postarticular Surface	14.4– 19.1	16.9	1.4	17
Prearticular Surface	16.8– 32.2	20.8	3.5	17
Centrum Length	23.6– 35.6	32.9	2.8	17
Pre-postzygapophyses	36.5– 40.5	38.6	1.3	17
C9 Depth	18.2– 22.7	20.2	1.2	17
Postzygapophyses	16.3– 25.0	20.8	2.0	17
Diapophyses	28.4– 34.5	31.2	1.8	17
Postarticular Surface	13.4– 17.9	15.4	1.3	17
Prearticular Surface	16.1– 21.7	19.0	1.4	17
Centrum Length	34.2– 38.7	36.2	1.4	17
Pre-postzygapophyses	38.2– 45.3	40.4	1.9	17
C10 Depth	19.7– 23.6	21.7	1.2	17
Postzygapophyses	19.8– 27.2	22.9	1.6	17
Diapophyses	28.8– 34.7	31.0	1.8	17
Postarticular Surface	12.6– 16.7	14.8	1.2	17
Prearticular Surface	15.2– 21.1	17.5	1.7	17
Centrum Length	36.0– 40.8	38.4	1.6	17
Pre-postzygapophyses	40.5– 50.6	44.2	2.3	17
C11 Depth	21.0– 24.9	23.2	1.2	17
Postzygapophyses	21.2– 27.5	23.4	1.5	17
Diapophyses	29.4– 34.7	31.5	1.6	17
Postarticular Surface	13.8– 18.4	15.4	1.4	17
Centrum Length	37.7– 43.2	40.7	1.7	17
Pre-postzygapophyses	43.6– 53.2	47.3	2.2	17
Prearticular Surface	15.1– 19.9	16.9	1.6	17
C12 Depth	23.0– 27.1	24.6	1.3	17
Postzygapophyses	20.2– 27.5	23.8	1.7	17
Diapophyses	30.1– 35.0	25.0	1.5	17
Postarticular Surface	14.6– 19.4	16.5	1.5	17
Prearticular Surface	15.4– 23.1	17.9	2.3	17
Centrum Length	39.5– 44.4	42.4	1.5	17
Pre-postzygapophyses	44.9– 53.7	49.7	2.3	17
C13 Depth	23.3– 28.2	25.7	1.5	17
Postzygapophyses	20.3– 27.0	23.8	1.9	17
Diapophyses	30.7– 37.3	33.7	1.7	17
Postarticular Surface	16.2– 20.6	17.8	1.4	17
Prearticular Surface	15.5– 22.6	18.9	1.9	17
Centrum Length	40.4– 45.9	43.6	1.6	17
Pre-postzygapophyses	47.7– 54.4	51.9	1.9	17
C14 Depth	24.3– 29.7	26.9	1.5	17
Postzygapophyses	20.7– 26.4	23.9	1.7	17
Diapophyses	32.0– 38.5	35.2	1.6	17
Postarticular Surface	17.3– 22.2	19.2	1.4	17
Prearticular Surface	17.1– 23.4	20.4	1.9	17

	<i>Range (mm)</i>	\bar{x}	s	n
Centrum length	41.0- 46.5	44.3	1.7	17
Pre-postzygapophyses	48.6- 56.6	52.8	2.3	17
C15 Depth	25.6- 32.2	28.6	2.0	17
Postzygapophyses	21.4- 27.4	24.1	1.6	17
Diapophyses	34.5- 40.9	37.1	2.0	17
Postarticular Surface	19.0- 23.5	21.2	1.4	17
Prearticular Surface	17.6- 25.9	22.0	2.1	17
Centrum Length	41.2- 47.4	44.9	1.8	17
Pre-postzygapophyses	49.8- 58.4	53.6	2.5	17
C16 Depth	27.5- 33.5	30.5	2.1	16
Postzygapophyses	22.4- 28.1	25.4	1.7	16
Diapophyses	36.9- 45.7	40.7	2.6	16
Postarticular Surface	20.5- 25.7	23.3	1.6	16
Prearticular Surface	20.4- 29.2	24.1	2.2	16
Centrum Length	41.9- 48.5	45.3	1.9	16
Pre-postzygapophyses	51.1- 60.8	55.0	2.8	16
C17 Depth	29.3- 41.1	33.8	3.2	17
Postzygapophyses	25.1- 30.4	27.2	1.9	17
Diapophyses	41.8- 51.4	45.7	3.2	17
Postarticular Surface	20.9- 27.6	24.5	1.9	17
Prearticular Surface	23.5- 32.4	26.5	2.2	17
Centrum Length	42.5- 48.7	45.5	2.0	17
Pre-postzygapophyses	50.0- 61.2	55.6	2.8	17
C or V18 Depth	34.0- 56.3	41.2	5.5	16
Postzygapophyses	25.3- 32.7	28.4	2.0	16
Diapophyses	46.5- 68.4	53.6	5.7	16
Postarticular Surface	21.9- 29.0	25.3	1.8	16
Prearticular Surface	22.4- 31.1	27.6	2.6	16
Centrum Length	42.3- 48.2	45.1	1.8	16
Pre-postzygapophyses	48.4- 60.6	55.4	3.0	16
V19 Depth	43.0- 66.4	50.7	6.3	17
Postzygapophyses	25.2- 31.3	28.3	1.7	17
Diapophyses	56.5- 70.6	61.7	4.0	17
Postarticular Surface	21.6- 27.8	24.9	1.8	17
Prearticular Surface	23.4- 33.1	27.4	2.5	17
Centrum Length	40.9- 47.5	44.4	1.9	17
Pre-postzygapophyses	51.4- 58.4	54.2	3.1	17
V20 Depth	50.7- 77.1	62.6	5.7	17
Postzygapophyses	23.7- 30.2	26.5	1.9	17
Diapophyses	62.1- 81.8	67.5	4.6	17
Postarticular Surface	20.5- 25.6	23.3	1.5	17
Prearticular Surface	23.7- 34.0	27.6	2.7	17
Centrum Length	40.4- 47.6	42.8	1.8	17
Pre-postzygapophyses	49.7- 58.3	54.2	2.4	17
V21 Depth	56.6- 78.1	68.0	5.5	17
Postzygapophyses	23.4- 29.1	26.2	1.6	17
Diapophyses	61.3- 82.0	68.2	4.8	17
Postarticular Surface	19.6- 26.5	22.7	1.5	17
Prearticular Surface	21.4- 29.4	25.3	2.0	17
Centrum Length	37.2- 46.3	42.1	2.4	17
Pre-postzygapophyses	47.9- 57.0	51.9	2.7	17
V22 Depth	57.1- 74.9	64.7	6.1	17
Postzygapophyses	22.4- 30.5	26.7	2.0	17
Diapophyses	61.0- 76.8	67.0	3.7	17
Postarticular Surface	19.8- 29.1	23.3	2.3	17
Prearticular Surface	21.9- 29.1	24.5	1.9	17
Centrum Length	38.3- 45.5	41.5	2.2	17
Pre-postzygapophyses	47.2- 57.8	50.7	2.9	17

	Range (mm)	\bar{x}	s	n
V23 Depth	55.7– 72.9	63.4	3.3	17
Postzygapophyses	25.8– 33.1	28.2	2.1	17
Diapophyses	60.9– 74.4	67.2	3.9	17
Postarticular Surface	21.0– 26.7	23.7	1.4	17
Prearticular Surface	20.3– 29.0	24.4	2.2	17
Centrum Length	37.8– 43.7	40.4	1.7	17
Pre-postzygapophyses	43.8– 51.6	47.1	2.1	17
V24 Depth	60.2– 79.9	68.7	4.6	17
Postzygapophyses	26.1– 33.8	30.4	2.2	17
Diapophyses	62.1– 75.5	68.7	4.1	17
Postarticular Surface	19.8– 28.4	24.3	2.3	16
Prearticular Surface	21.3– 28.8	24.7	2.3	17
Centrum Length	37.5– 46.1	41.3	2.0	17
Pre-postzygapophyses	43.2– 52.1	46.9	2.1	17
V25 Depth	63.7– 85.9	74.1	5.2	17
Postzygapophyses	27.9– 40.2	33.8	2.8	17
Diapophyses	43.4– 76.2	68.7	7.7	17
Postarticular Surface	20.3– 27.3	23.8	1.9	17
Prearticular Surface	20.4– 30.3	25.2	2.5	16
Centrum Length	36.8– 44.4	41.2	2.0	17
Pre-postzygapophyses	42.3– 52.9	46.3	2.2	17
V26 Depth	68.5– 87.8	79.4	5.2	15
Postzygapophyses	26.2– 40.9	33.7	3.9	16
Diapophyses	59.7– 75.6	69.2	4.6	15
Postarticular Surface	23.0– 30.4	25.0	1.9	15
Prearticular Surface	23.1– 38.7	25.8	3.8	15
Centrum Length	33.3– 49.4	40.6	3.6	16
Pre-postzygapophyses	41.2– 50.7	45.3	2.9	15

TABLE 3. Measurements (in mm) of skull material of fossil emus (Dromaiinae) from Australia.

SPECIMEN	Width	Depth	Diameter, Foramen Magnum	Lower Jaw, Symphysial Length
NMV P157345	75.0 (est.)	47.4	10.8	—
NMV P157350	—	—	—	21.5
NMV P157353	>65.2	48.5	10.7	—
SAM P17834	—	—	—	24.5

TABLE 4. Measurements (in mm) of vertebrae of fossil emus (*Dromaiinae*) from Australia.

SPECIMEN	Measurements							Vertebral Number
	Width					Length of Centrum	Length across Zygapop.	
	Depth	Postzyg.	Diapop.	Posterior Articulation	Anterior Articulation			
MM F16786	—	42.2 (est.)	—	25.5 +	30.0 (est.)	37.7	46.3	V24?
MM F16797	—	31.8	—	27.0	27.2	38.8	42.1	V26 or 25?
NMV								
P157346	—	23.6	—	20.2	23.2	39.3	46.3	V21 or 22
NMV								
P157349	—	—	62.8 (est.)	21.4	22.2 (est.)	36.0	—	V23 or 24
NMV								
P157351	14.3	9.7	24.6	16.9	12.8	24.5	30.2	C7? (juv)
NMV								
P157352	18.2	17.7	—	11.9	12.4 (est.)	31.2	37.8	C11-13? (juv)
NMV								
P157359	22.5	26.1	21.7	8.7	9.2	17.5	24.2	C3
NMV								
P157364	—	—	68.0 (est.)	—	—	—	—	V25 or 26
NMV								
P157367	—	19.8	46.8 (est.)	—	—	—	>36.3	V20-21 (juv)
NMV								
P157368	16.6 +	16.6 +	—	11.0	16.2 (est.)	29.2	32.4	?C11 (juv)
NMV								
P157369	—	—	—	21.4 (est.)	26.0 (est.)	27.0	—	V22-26 (juv)
SAM P17589	29.7	23.1	39.7	21.8	23.1	47.4	54.0	C16 (15-17?)
SAM P18246	19.9	23.9	22.5	10.7	9.8	23.2	29.5	C4
SAM P18673	30.5	27.5	37.9 +	20.6	18.8 +	48.1	—	C15-C17
SAM P18830	—	33.4	—	27.4	>25.6	39.7	44.0	V26?
SAM P18247	—	—	68.0 (est.)	24.8	—	41.9	—	V22 or 23
AMNH 9678	—	26.0 (est.)	—	—	—	—	—	C2
AMNH 9678	24.2 +	30.0 (est.)	22.0 (est.)	—	11.2 (est.)	22.5 +	26.7	C3
AMNH 9678	>20.2	29.1	25.9	12.6	11.7	25.6	33.1	C4
AMNH 9678	18.0	16.8	32.9	22.8	19.5	32.4	46.6	C6?
AMNH 9678	19.1	16.3	34.9	23.1	23.3	35.5	45.5	C7?
AMNH 9678	21.7	—	36.4	—	22.5	>37.8	48.0	C9?
UCMP 56642	—	—	—	—	—	41.7	48.5	V21 or 22
UCMP 56855	—	—	—	23.3	25.7	46.6	—	V22 or 23

TABLE 5. Measurements (in mm) of vertebral ribs of fossil emus (*Dromaiinae*) from Australia.

SPECIMEN	Width of Facets
NMV P157354	>36.8
NMV P157358	~34.3
NMV P157362	>28.0
SAM P18107	29.3
SAM P18784	34.1
SAM P22812 (in part)	38.6
UCMP 60560	34.8

TABLE 6. Measurements (in mm) of sterna of fossil emus (Dromaiinae) from Australia.

SPECIMEN	Maximum Length	Maximum Width	Number of Costal Processes	Width of first Costal Process	Width of last Costal Process	Length of Costal Margin	Length of Sterno-coracoidal Process	Width of Coracoidal Sulci	Anterior Depth
<i>D. novaehollandiae</i>									
NMV P157347	—	124	3	~118	—	—	—	~52.6	14.6
NMV P157355	—	112	4	109	90.9	49.7	16.4	—	—
<i>D. sp.</i>									
AMP 25218	147	118	4	~127	109	64.2	—	70.5	17.9

TABLE 7. Measurements (in mm) of synsacra of fossil emus (Dromaiinae) from Australia.

SPECIMEN	Diameter of Acetabular Foramen	Width across Antitrochanter	Length of Acetabular Complex	Depth of Acetabular Complex
<i>D. novaehollandiae</i>				
NMV P157361	—	>83.6	56.3	—
SAM Unreg.	15.5	—	—	—
SAM P16501	18.0	108	—	—
SAM P17767	12.2	104	60.7	33.8
UCMP 56333	17.4	—	62.3	36.8

TABLE 8. Measurements (in mm) of femora of fossil emus (Dromaiinae) from Australia.

SPECIMEN	Length	Proximal Width	Proximal Depth (Trochanter)	Diameter of Head	Distal Width	Depth of External Condyle
<i>D. novaehollandiae</i>						
HM B775/869	190	—	—	—	59.6	61.2 R
HM B801/934	—	—	—	—	—	76.2 d,R
RHT 1064	190	65.1	—	27.6	—	— R
SAM Unreg.	—	—	—	27.4	>76.3	76.7
SAM P17104	—	-67.2	-61.2	-28.0	—	— p,L
SAM P22812	204	67.4	61.4	25.5	68.8	— L
AMNH 9677	—	—	—	—	83.3	70.7 d,R
<i>D. cf. ocybus</i>						
UCMP RAS5176	190	59.5	—	—	—	— p,L

TABLE 9. Measurements (in mm) of tibiotarsi of fossil emus (*Dromaiinae*) from Australia.

SPECIMEN	Length	Diameter of Shaft		Proximal Depth	Proximal Width	Length, Fibular Crest	Depth, Internal Condyle	Depth, External Condyle	Width, Distal End
		Minimum	Maximum						
<i>D. novaehollandiae</i>									
AM 49713	—	—	—	113	57.8	—	—	—	— p,R
AM 'B'	—	—	—	—	—	—	45.1	—	46.6 d,L
AM F10949	—	—	—	—	—	—	>35.0	31.2	38.1 d,L
AM P5802	—	—	—	—	—	—	41.0	42.1	47.3 d,R
MM F16775	—	—	—	—	—	—	44.9	44.3	49.5 d,R
NMV P44011	—	22.1	26.6	>76.0	>44.1	93.1	—	—	— R
NMV P150013	—	24.9	32.7	—	—	95.1	44.7	40.2	50.4 d,L
NMV P157356	—	—	—	>92.2	47.4	—	—	—	— p,R
NMV P157357	—	—	—	—	—	—	39.1 ⁺	39.1	43.3 d,L
NMV P157360	—	—	—	—	—	—	>39.3	39.3	41.8 d,L
NMV P157365	—	21.1	29.2	>91.5	49.2	96.4	—	—	— p,R
QM F1652	—	—	—	—	56.1	>80.5	—	—	— p,L
SAM P17149	—	—	—	—	—	—	42.7	—	43.6 d,R
SAM P18829	—	—	—	—	—	—	>38.8	41.3 ⁺	>37.5 d,R
SIAM 61	384	23.3	32.3	102	56.9	88.6	45.8	43.9	51.8 L
UCMP 53825 (RHT6)	—	—	—	—	—	—	37.0	35.1	37.4 d,L
UCMP 53825 (RHT25)	—	—	—	—	—	—	37.0	34.9	35.6 d,L
UCMP 56845	—	—	—	—	—	—	—	38.8	40.6 ⁺ d,L
WAM 68.5.34	—	21.6	26.3	—	—	107	—	—	— L
<i>D. 'patricus'</i>									
MM F12074	—	—	—	—	—	—	35.5	34.3 ⁺	41.3 d,R
QM F5547	—	—	—	—	57.6	>90.2	—	—	— p,R
QM F5548	—	—	—	—	—	—	46.2	45.7	48.6 d,L
<i>D. cf. ocybus</i>									
UCMP RAS5182	—	—	—	—	—	—	43.0	40.8	46.0 d,R
<i>D. gidju</i>									
SAM P26779	—	—	—	—	—	—	31.8	31.3	32.0 d,L

TABLE 10. Measurements (in mm) of tarsometatarsi of fossil emus (Dromaiinae) from Australia.

SPECIMEN	Length	Diameter of Shaft		Proximal Width	Depth, Internal Cotyla	Depth, External Cotyla	Depth, Hypotarsus	Distal Width	
		Minimum	Maximum						
<i>D. novaehollandiae</i>									
AM Unreg.	—	—	—	56.7	25.9	24.5	42.5 ⁺	—	p,R
AM 'C'	—	—	—	53.9	25.2	21.3	40.5 ⁺	—	p,L
AM F771	—	11.8 ⁺	20.5	—	—	—	—	47.5	d,R
AM F18935	—	14.0	19.4	—	—	—	—	>46.2	d,L (juv)
AM P58026	—	—	—	53.0	23.2 ⁺	19.1 ⁺	39.5 ⁺	—	p,R
NMV L5	—	—	—	—	—	—	—	54.1 ⁺	d,L
NMV P44012	—	14.1	21.9	>42.3	—	—	>34.0	52.4	R
NMV P44013	—	16.1	22.2	48.3	26.3	22.5 ⁺	>35.1	55.9	R
NMV P44014	—	14.9	19.8	49.8	24.2	21.4	37.5 ⁺	52.2	R
NMV P44015	—	14.0	19.5	46.5	24.0 ⁺	19.8	>37.0	—	R
NMV P44016	—	15.5	20.4	—	23.0	>21.8	>38.2	51.2	L
NMV P44017	—	13.3	21.7	—	—	—	—	>50.5	d,L
NMV P44018	—	13.8	23.1	—	—	—	—	54.0 ⁺	d,L
NMV P48392	—	12.2	21.0	—	—	—	—	—	d,R
NMV P150015	—	16.7	23.6	—	—	—	—	—	d,R
NMV P157343	—	13.0	19.3	>39.0	—	—	>32.4	—	L
NMV P157344	—	14.2	19.6	—	—	—	—	—	d
QM F1143 (in part)	—	15.4	25.7	—	—	—	—	56.1	L
SAM P13118	—	12.6	—	—	—	—	—	—	d,R
SAM P17816	—	16.0	23.4	—	—	—	—	53.5	d,L
SAM P18693	—	16.7	23.9	49.0 (est.)	—	—	—	56.3	L
UCMP 53835	—	13.9	18.7 ⁺	—	—	—	—	39.0	d,R
UCMP 56313	—	13.5 ⁺	—	—	—	—	—	—	d,R
WAM Unreg. 190	—	—	—	33.8	—	—	—	—	(juv)
WAM 68.5.34	>330	16.6	18.2	—	—	—	—	—	L
<i>D. 'gracilipes'</i>									
QM F1142	—	10.9	21.5	—	—	—	—	—	d,L (juv)
<i>'Metapteryx bifrons'</i>									
QM F1135	—	—	—	—	—	—	—	34.1	d,L (juv)
<i>D. ocypus</i>									
SAM P13444	330	—	—	47.1	21.2	20.9	35.5 ⁺	53.0	R
<i>D. gidju</i>									
SAM P26779	—	—	—	35.0	18.9	14.8 ⁺	26.9 ⁺	—	p,L
<i>D. sp.</i>									
AM 'A'	—	10.3	17.1	—	—	—	—	—	d (juv)
AM F10850	—	—	—	46.4	—	—	—	—	p,L
NMV P35578	—	16.2	28.0	—	—	—	—	—	d,R
<i>Aves, indet.</i>									
SAM P11552	—	21.2	28.0	—	—	—	—	63.7	d,L

TABLE 11. Measurements (in mm) of the distal ends of tarsometatarsi of fossil emus (*Dromaiinae*) from Australia.

	Width, T2	Width, T3	Width, T4	Depth, T2	Depth, T3	Depth, T4
<i>D. novaehollandiae</i>						
AM F771	9.1	23.8	12.2	12.1	20.3	13.9
AM F18935	—	24.1	12.3	—	24.1	14.2
QM F1135	5.9	15.7	7.5	8.8	13.8	9.4
QM F1143 (in part)	10.9	27.2	14.3	15.3	25.0	15.8
QM F1143 (in part)	—	23.0	—	—	22.6	—
NMV L5	>10.5	24.8 ⁺	13.2 ⁺	>14.0	25.2 ⁺	15.9
NMV P44012	> 9.2	24.3	12.8 ⁺	13.1 ⁺	22.3 ⁺	16.0
NMV P44013	9.8 ⁺	24.3	14.5 ⁺	15.1	23.8	16.8
NMV P44014	10.9	26.4	13.2	14.8	22.5	15.7
NMV P44015	—	—	—	—	21.4 ⁺	—
NMV P44016	10.3	25.9	13.3	13.8	21.4	14.7
NMV P44017	> 8.8	>23.3	>13.1	14.8	23.3	15.4
NMV P44018	> 9.0	25.0 ⁺	14.8	13.4 ⁺	20.4 ⁺	14.7 ⁺
NMV P48392	—	—	>10.5	—	>21.5	12.4 ⁺
NMV P150014	11.3	28.3	—	15.0 ⁺	24.0	—
NMV P150015	14.9 ⁺	25.1	—	11.6	29.8	—
SAM P13118	—	—	11.9	—	20.2 ⁺	12.7
SAM P17816	10.0	27.8	>13.3	15.0	23.1	15.6
SAM P18693	12.6	29.8	15.6	>15.3	25.6	>18.0
UCMP 53835	—	>18.4	—	—	—	—
UCMP 56313	10.7	27.9	—	15.3	23.1	—
<i>D. 'gracilipes'</i>						
QM F1142	—	16.6	—	—	16.5	—
<i>D. ocybus</i>						
SAM P13444	10.6	27.8	13.5	14.7	21.9	15.7
<i>D. sp.</i>						
AM 'A'	—	16.5	—	—	~14.7	—
QM QA205	—	~16.1	—	—	>14.4	—
QM QA416	13.3*	—	—	23.9*	—	—
QM QA505	8.5	17.5	—	11.9	16.8	—
UCMP RAS5397 (in part)	—	15.7 ⁺	—	—	14.0 ⁺	—
<i>Aves indet.</i>						
SAM P11552	—	>26.3	>14.5	—	>27.5	—

* perhaps T4

TABLE 12. Measurements (in mm) of phalanges of fossil emus (Dromiinae) from Australia.

SPECIMEN	Phalanx	Length	Proximal Depth	Proximal Width	Element
<i>D. novaehollandiae</i>					
SAM P18059	P1,DII	45.0	20.0	14.8	L
SAM P18248	P2,DII	37.6	17.8	23.8	R
SAM P18249	P1,DIV	38.2	17.6	18.8	R
UCMP 53832	P4,DII or DIV	20.6	10.6	10.5	
UCMP 53832	P1,DII	—	16.7	13.4	p
UCMP 53832	P2,DIV	16.3	12.3	14.1	L
UCMP 53833	P1,DIV	34.2	16.1	17.8	L
UCMP 53833	P5,DIV?	20.0 ⁺	9.6	8.6 ⁺	
UCMP 55983	P1,DIII	53.2	20.8	25.7	L
UCMP 55983	P2,DIII	36.2	13.9	21.3	L
UCMP 56849	P1,DII	43.0	18.9	17.0	L
UCMP 94679	P1,DIII	48.4	18.9	24.0	
UCMP 94680	P2,DIII	37.0	18.8	21.4	L
<i>D. gidju</i>					
SAM P26779	P1,DII	33.1	14.2	12.9	L
SAM P26779	P2,DII	23.5	11.8	11.6	L
SAM P26779	P3,DII	19.3	10.1	8.9	L
SAM P26779	P1,DIII	45.1	16.7	19.5	L
SAM P26779	P2,DIII	31.7	12.9	15.2	L
SAM P26779	P3,DIII	22.5	10.5	13.0	L
SAM P26779	P4,DIII	18.4	9.8	10.5	L
SAM P26779	P1,DIV	29.2	13.0	14.0	L
SAM P26779	P2,DIV	16.1	10.6	10.8	L
SAM P26779	P3,DIV	10.8	9.2	9.4	L
SAM P26779	P4,DIV	8.8	7.9	8.2	L
SAM P26779	P5,DIV	15.6	8.8	7.7	L
<i>D. sp.</i>					
QM QA504	P1,DIII	41.5	15.3	16.8	R
UCMP RAS 5397	P2,DII	19.8	11.9	10.9	L

TABLE 13. Measurements (in mm) of the fibula of fossil emus (Dromaiinae) from Australia.

SPECIMEN	Proximal Width	Proximal Depth	Element
NMV P157363	17.0	36.4	p,L

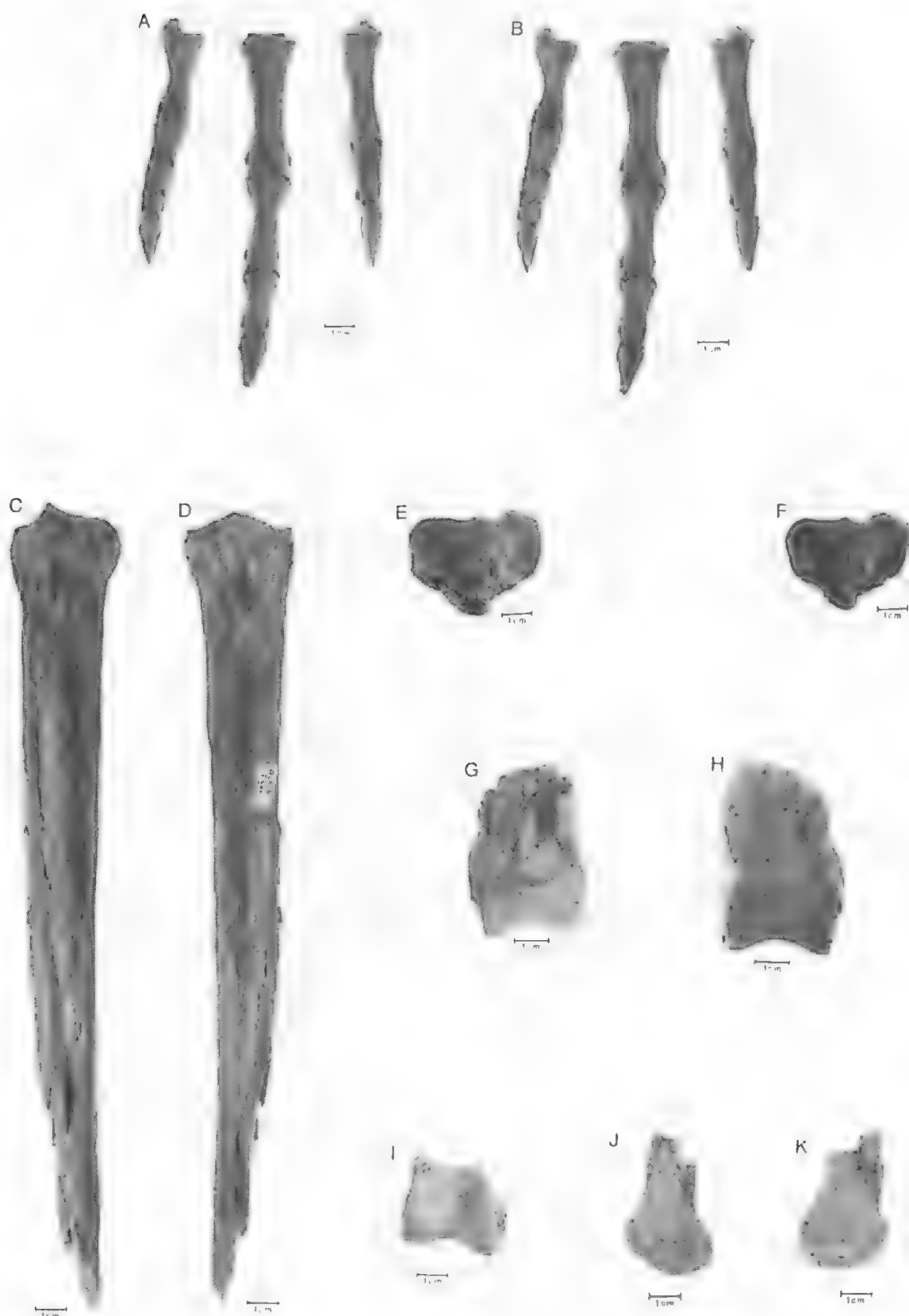


FIGURE 1, *Dromaius gidju*, n. sp. Type from the Wipajiri Fm. Leaf Locality, Lake Ngapakaldi, Kutjamarpu fauna, Miocene. A,B, stereo pair of pes, dorsal view. C,D,E,F, tarsometatarsi in posterior (C), anterior (D) and proximal (E,F, stereo pair) views. G,H,I,J,K, distal left tibiotarsus in anterior (G), posterior (H), distal (I), internal (J), and external (K) views. Scale indicates 1 cm.



FIGURE 2. Mid-Cainozoic emu fossils from northern South Australia and living casuariiids. A-D, posterior views of tarsometatarsi of (A,B) the extant *Dromaius novaehollandiae*, (C) *D. ocypus* (SAM P13444), and (D) the extant *Casuarus unappendiculatus* (from Miller, 1963). E,F, stereo pair in anterior view, tarsometatarsus, the type specimen of *Dromaius ocypus*, SAM P13444, Pliocene, Lawson-Daily Quarry, Mampuwordu Sands, Lake Palankarinna, Palankarinna fauna. G, distal tibiotarsus in anterior view of *D. cf. ocypus*, RAS 5182, Pliocene. H,I, femur of *D. cf. ocypus*, in posterior (H) and anterior (I) views, RAS 5176, Pliocene.



FIGURE 3. A variety of late Cainozoic emu fossils. A, sternum of *Dromaius* sp. in dorsal view, AM F25218. B, pelvic fragment of *D. novaehollandiae* in lateral view, SAM P16501. C, distal left femur in posterior view of *D. novaehollandiae*, HM B801/B934. D,E, proximal right tibiotarsus in lateral (D) and proximal (E) views. F, left tibiotarsus in anterior view, SIAM 61.

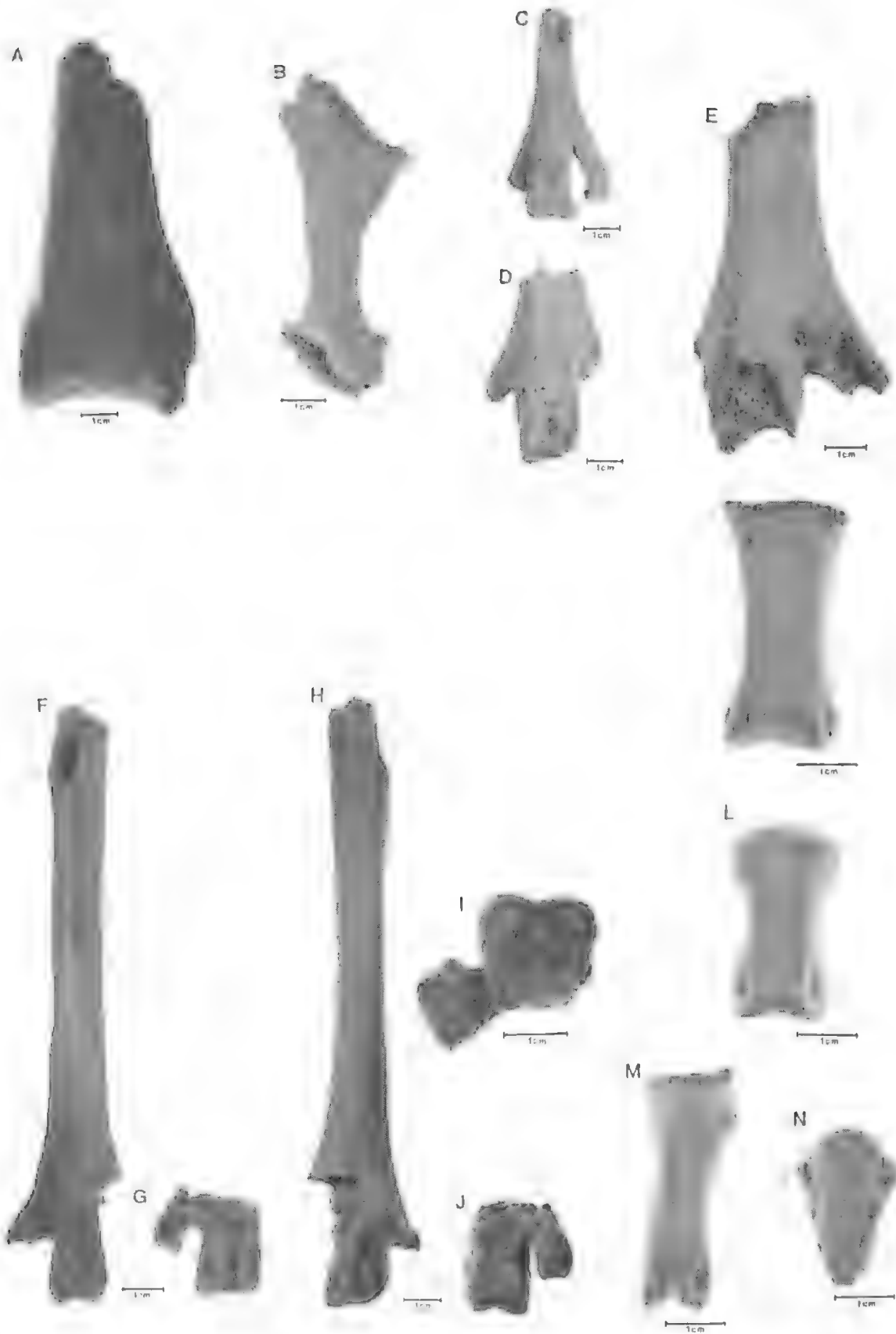


FIGURE 4. A variety of late Cainozoic emu fossils. A, distal right tibiotarsus in anterior view, one of the original type specimens of *Dromaius 'patricius'* De Vis, QM F5548. B, QM F1120 considered by C.W. De Vis to be a coracoid of *D. patricius*, but non-avian. C, distal left tarsometatarsus of '*Metapteryx bifrons*' De Vis in anterior view, QM F1135, originally designated a kiwi but actually a juvenile *D. novaehollandiae*. D, distal tarsometatarsus of *D. gracilipes* De Vis in anterior view, QM F1142, a juvenile *D. novaehollandiae*. E, distal left tarsometatarsus of Aves indet. cf. dromornithid in anterior view, SAM P11552, assigned previously as emu. F, H, tarsometatarsus fragment of a small *D. novaehollandiae* in anterior (F) and posterior (H) views, AM 'A', no locality or age data available. G, I, J, second and third trochleae of a small *Dromaius* in posterior (G), distal (I), and posterior (J) views, QW QA505. K-N, phalanges of *D. novaehollandiae* in dorsal views. (K) phalanx 1 digit III, UCMP 94679; (L) phalanx 2, digit III, UCMP 94680; (M) phalanx 1, digit II, UCMP 56849; and (N) ungual phalanx 4, digit III, UCMP 60563.

ECHIURANS FROM AUSTRALIA (ECHIURA)

BY *S. J. EDMONDS*

Summary

Seventeen species of euchiurans [i.e. echiurans] are recorded from Australia of which nine are redescribed, and none are new. One, *Anelassorhynchus porcellus adalaidensis*, is given new status. *Listriolobus bulbocaudatus* Edmonds, 1963 is now considered a junior synonym of *L. brevirostris* Chen & Chen Chang, 1958, *Ochetostoma myersae* Edmonds, 1963 a junior synonym of *O. baroni* Greeff, 1879 and *Austrobonellia mjoebergi* (Fischer, 1921) a junior synonym of *Pseudobonellia biuterina* Johnston & Tiegs, 1919. A key to the Australian species is given.

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S. J. EDMONDS

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Echiurans are soft-bodied, protostomous, coelomate, worm- to sausage-shaped, marine invertebrates that resemble annelids and sipunculans. Because they are largely subtidal and occur in burrows and protected places echiurans are not always easy to find. They have, however, been collected in tropical, temperate and polar seas and are known from the littoral to the ultra-abyssal regions of the oceans. More than 150 species have been described.

Records of Australian echiurans are few and scattered (Haswell 1885, Whitelegge 1899, Augener 1903, Hedley 1906, Dakin 1916 and 1952, Fischer 1919 and 1921, Johnston & Tiegs 1919 and 1920, Monro 1931, Edmonds 1960, 1963, 1966 and 1982, Nielsen 1963, Dartnall 1970 and 1976) and only 16 species have so far been reported, of which three are well known. In Australia echiurans have been found in burrows in mud and sand, in limestone rocks and in coral, in tangled roots of sea-grasses, under stones and in cracks and fissures in rocks. Some have been dredged. The best known Australian echiurans (and ones that can be readily collected) are *Metabonellia haswelli*, *Anelassorhynchus porcellus adalaidensis* and *Ochetostoma australiense*. Scuba divers report the presence of large numbers of the first in shallow water at Encounter Bay, S.A., between Wright I. and the Bluff and from the islands comprising the Banks Group in Spencer Gulf, S.A. and of the second species from Coobowie and Edithburg in St Vincent Gulf, S.A. Large numbers of *O. australiense* occur at Caloundra and Dunwich, Qu., the species feeding from the surface of intertidal mud flats at low water. In other parts of the world they have also been found in the empty shells of molluscs and in sand dollars. Most of the specimens examined in the present study were found intertidally by collectors or subtidally by divers and are now in the collections of State Museums.

The classification used in this paper is that outlined by Stephen & Edmonds (1972), which in turn is based on that of Fisher (1946).

LIST OF AUSTRALIAN ECHIURANS

The species marked '*' have not been examined by the author. Records of species marked '?' are considered doubtful.

Family Bonelliidae

- Metabonellia haswelli* (Johnston & Tiegs)
- Pseudobonellia biuterina* Johnston & Tiegs
- ?* *Archibonellia michaelsoni* Fischer
- * *Zenkevitchiola brevirostris* Murina
- * *Sluiterina alba* Murina
- * *Vitjazema ultraabyssalis* Murina
- * *Protohonellia papillosa* Murina

Family Echiuridae

- Anelassorhynchus porcellus porcellus* Fisher
- Anelassorhynchus porcellus adalaidensis* Edmonds n. status.
- ?* *Anelassorhynchus vegrandis* (Lampert)
- Arhynchite hiscocki* Edmonds
- Listriolobus brevirostris* Chen & Yeh Chen-Chang
- ?* *Listriolobus sorbillans* (Lampert)
- Ochetostoma baroni* (Greeff)
- Ochetostoma australiense* Edmonds
- Thalassema sydneyense* Edmonds

Family Ikedaidae

- Ikeda* sp.

The following abbreviations are used in this paper: AMS (Australian Museum, Sydney), MV (Museum of Victoria, Melbourne), SAM (South Australian Museum, Adelaide), WAM (Western Australian Museum, Perth), TMH (Tasmanian Museum, Hobart), N.S.W. (New South Wales), Qu. (Queensland), S.A. (South Australia), Tas. (Tasmania), Vic. (Victoria), W.A. (Western Australia.). The anatomy of a 'generalised' echiuran is shown in Fig. 1.

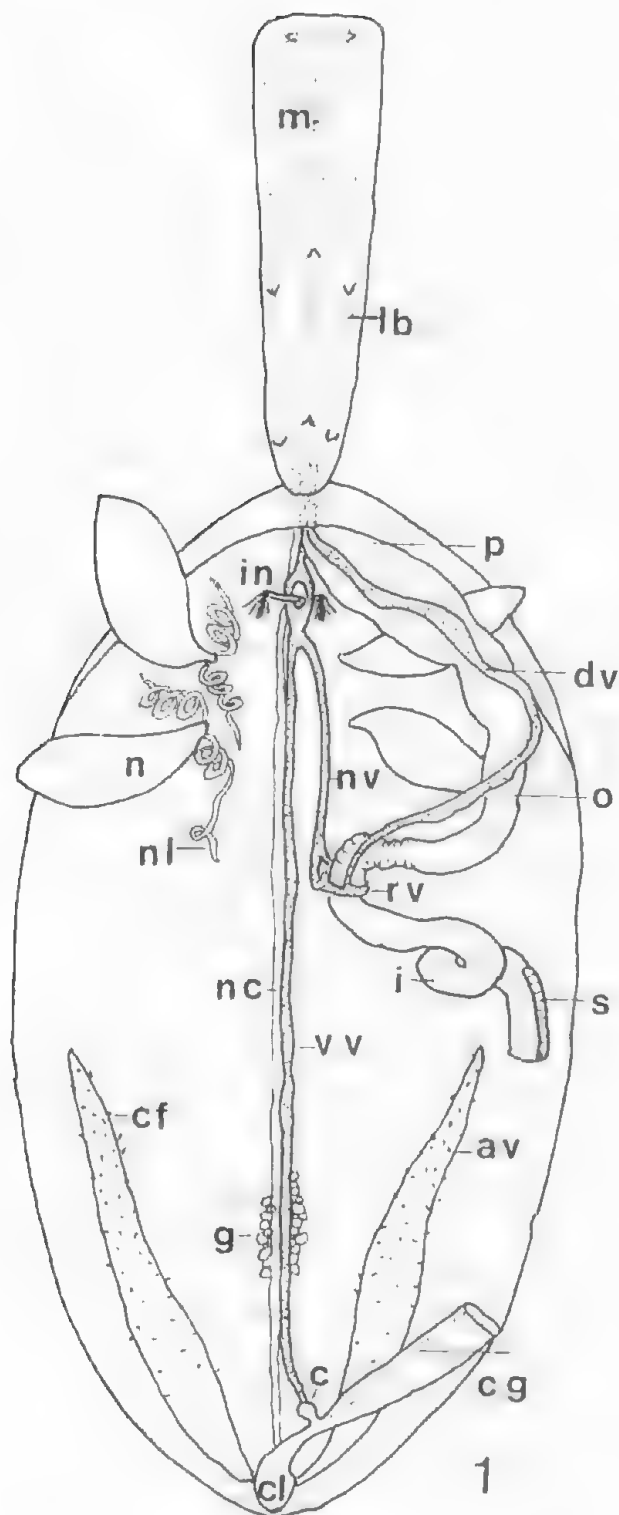


FIGURE 1. A generalized diagram to show some of the internal anatomy of an echiuran; dorsal view. Most of the much coiled intestine has been omitted. av, anal vesicle; c, caecum; cf, ciliated funnel; cg, ciliated groove; cl, cloaca; dv, dorsal vessel; g, gonad; i, intestine; in, interbasal muscle; lb, lateral vessel; m, median vessel; n, nephridia; nc, nerve cord; nl, nephrostomal lips; nv, neurointestinal vessel; o, oesophagus; p, pharynx; rv, ring vessel; s, siphon; vv, ventral vessel.

KEY TO GENERA OF AUSTRALIAN ECHIURANS

The doubtful genus *Archibonellia* has not been included in the key; it would key near *Pseudobonellia*.

1. Proboscis bifid 2
 Proboscis not bifid 3
2. One nephridium, with distally placed, stalked nephrostome *Metabonellia*
 Two nephridia with a small sac carrying a male between them *Pseudobonellia*
3. Longitudinal musculature of body wall grouped into bands 4
 Longitudinal musculature of body wall not grouped into bands 6
4. Nephridia less than 10 and arranged in pairs; trunk long or short 5
 Nephridia very numerous and not in pairs; trunk very long, up to 400 mm *Ikeda*
5. Intervals between longitudinal muscle bands traversed by small bundles (fascicles) of oblique muscles *Ochetostoma*
 Intervals between longitudinal muscle bands not traversed by small bundles of oblique muscles *Listriolobus*
6. Nephrostome distal *Vitjazema*
 Nephrostome basal 7
7. Ventral setae none 8
 Ventral setae two 9
8. Anal glands long and slender; posterior region of proboscis surrounded by a collar *Zenkevitchiella*
 Anal glands bushy or feathery; posterior region of proboscis modified to form a cup... *Sluiterina*
9. Nephrostomal lips long and spirally coiled *Anelassorhynchus*
 Nephrostomal lips long or short but not spirally coiled 10
10. Anal glands tubular or sac-like 11
 Anal glands feathery or bushy *Protobonellia*
11. Proboscis with expanded or fan-like anterior extremity *Arhynchite*
 Proboscis without expanded or fan-like anterior extremity *Thalassema*

DESCRIPTION OF GENERA AND SPECIES

Genus *Metabonellia* Stephen & Edmonds

Metabonellia Stephen & Edmonds, 1972, p. 394.

Type-species: *Bonellia haswelli* Johnston & Tiegs, 1920. (*Bonellia gigas* Nielsen, 1963, which was named as type by Stephen & Edmonds (1972) is now

considered to be a junior synonym of *B. haswelli*). The genus contains only one known species.

Diagnosis

Female of medium to large size, with proboscis blind, grooved and ciliated on ventral surface. Pale to dark green. Two ventral setae. Single nephridium with nephrostome on a short stalk placed about two thirds of way along nephridium towards its distal extremity. Anal vesicles branching. Intestinal siphon present. Male worm-like, as long as 20 mm and without setae. Found in nephridium of female.

Metabonellia haswelli (Johnston & Tiegs) (Figs 2-4, 18)

Bonellia haswelli Johnston & Tiegs, 1920, pp. 73-76; Edmonds, 1960, pp. 95-96.

Bonellia gigas Nielsen, 1963, pp. 61-67.

Bonellia tasmanica Dartnall, 1970, pp. 69-71.

Metabonellia haswelli Stephen & Edmonds, 1972, pp. 394-395; Dartnall 1976, pp. 1041-1043; Edmonds 1982, pp. 314-316.

Holotype: AMS G1122 and paratype G1261. 'Type locality, Sydney Harbour, N.S.W., 'under stones just above the limit of low water'.

Previous Australian records: Johnston & Tiegs (1920), Edmonds (1960), Nielsen (1963), Dartnall (1976).

Description of female

Trunk: Medium to large, shape variable (sausage to sub-ovoidal), light to dark green, length 20-80 mm (Nielsen 1963; length 80-120 mm, maximum width 40 mm). Skin smooth to rough, usually covered anteriorly and posteriorly with near circular rows of rather flattened papillae. Thickness of body wall variable, longitudinal musculature continuous.

Proboscis: Firmly attached, long, blind and capable of great extension, maximum length in fixed specimens 260 mm. Arms short and usually of about equal length, 20-30 mm. Lateral edges tend to roll inwards, ventral surface ciliate, dorsal surface smooth.

Setae: Two, together with reserve setae, ventrally placed and posterior to mouth. Setal but no interbasal muscle present.

Alimentary Canal: Mouth at base of proboscis, canal much coiled and fastened to body wall by numerous strands of muscle. Consists of (1) foregut (divided into pharynx, oesophagus, crop and gizzard), (2) midgut (wider and longer than foregut), associated for most of its length with a collateral intestine or siphon and (3) hindgut and cloaca. Siphon tubular, of smaller diameter than

intestine and arising near beginning of midgut. A ciliated groove lies in wall of much of posterior intestine. No precloacal caecum. Faecal matter forms pellets. Anus at posterior extremity of trunk.

Nephridium: Single, attached to coelomic wall of trunk just posterior to level of setae. Size variable, depending on reproductive condition of animal. Wall of anterior and posterior regions usually (thicker than thin, often transparent, middle region, which seems capable of much extension and even sacculation. Nephrostome distal, situated about three-quarters to two-thirds length of nephridium away from nephridiopore. Nephrostomal lips frilled or crenated, situated at end of short stalk. Nephridium holds eggs and/or a male (two males in one specimen). Eggs develop in coelom along a mesentery associated with ventral blood vessel and nerve cord. Diameter of largest eggs 0.50-0.55 mm.

Vascular System: Thin walled ventral blood vessel. Single neurointestinal vessel, arising posteriorly from two short arms on each side of anteriormost region of intestinal siphon, joins ventral vessel in anterior half of trunk. Thin walled dorsal vessel fuses with intestine near posterior extremity of foregut. Anterior continuations of ventral and dorsal vessels extend into proboscis. Neurointestinal vessel often vesiculated or superficially roughened and coloured dark yellow to orange.

Anal Vesicles: Two, much branched, tufted and each a complex of tubes and tubules. Johnston & Tiegs (1920, p. 75) described them thus: 'Into the cloaca open two anal vesicles Into each open about 15 tubules, some quite short, others much longer. These tubes give off smaller or larger numbers, at times very large numbers, of secondary nephridial [?] excretory] tubes, each ending in a narrow neck which bears a circular disc with the nephrostome opening in its centre. The disc is composed of a ring of compressed elongated cells, with strongly staining nuclei and fringed with a ring of cilia'. In larger specimens the vesicles are larger and the branches more tufted.

Description of male (based on four stained and mounted specimens)

Located in nephridia of females but not permanently attached like male of *Pseudobonellia hiuterina*. Long, thin or flat but swollen or rounded anteriorly, tending to taper posteriorly; largest about 20 mm long, maximum width 1.2, lacking setae. Body wall very thin. Outline of what might be a rudimentary gut runs through most of animal; body cavity contains developing sperm morulae. Cilia on some regions of body surface.

No males were found by Johnston & Tiegs (1920). The male of *Bonellia gigas* Nielsen, 1963 is 19 mm long and 0.5-1.0 mm wide, lacking setae but

possessing a posterior sucker or clasper. The male of *Bonellia tasmanica* Dartnall, 1970 is 7 mm long, 0.8 mm wide, tapering posteriorly and lacking both setae and clasper.

Systematics

Bonellia gigas Nielsen, 1963, described from a very large bonelliid collected at Western Port, Vic., was considered to be different from *B. haswelli* chiefly because it lacked an intestinal siphon. Although I have not been able to dissect the type of *B. gigas*, I have dissected one specimen from Port Phillip Bay and another from Flinders. Both have siphons. Further, Fig. 2 of Nielsen, 1963, clearly shows a siphon attached to part of the gut, especially the posterior part. Nielsen apparently mistook the siphon for a continuation of the neurointestinal vessel and labelled it 'intestinal blood vessel'.

Dartnall (1970) described *B. tasmanica* from northern Tasmania, arguing that it differed from *B. haswelli* because it lacked a siphon and from both *B. haswelli* and *B. gigas* because its nephridia were sacculated. It is probable that what Dartnall described as 'an intestinal vessel, which runs closely along the wall of the intestine for about the posterior two thirds of its length' and then 'leaves the gut and joins the ventral vessel' is in part a siphon and in part a neurointestinal vessel. The sacculated condition of the nephridium of *B. tasmanica* is a doubtful character and was probably caused by temporary muscular contractions of the organ at the time of fixation. In one specimen from S.A. the thin walled part of the nephridium is constricted near its middle so as to form two sacs.

From a study of male and female specimens of *B. haswelli*, *B. gigas* and *B. tasmanica* it is concluded that the three species are synonymous, the first name having priority. Stephen & Edmonds (1972) transferred the species to a new genus *Metabonellia* on account of the distal position of its nephrostome. Johnston & Tiegs' specimens from N.S.W. were small but Nielsen's from Victoria were very large.

Specimens examined and localities

New South Wales: Fairlight (near Manly) (1) AMS W5612 and (3) AMS W4702 (two of these clearly show the relationship between the neurointestinal vessel and the siphon); Camp Cove, Sydney Harbour (1) AMS W8703; locality unknown (1) SAM E1404.

Victoria: Port Phillip Bay near Port Arlington (2) MV coll. and at Mornington (1) MV coll.; Flinders, Western Port Bay, SAM E1400 (1) and type male and female of *B. gigas* MV G2696 and 2697; Port Phillip Survey area 3f 'inside buoy' (1) SAM E1407.

Tasmania: Jacobs Boat Harbour (north Tasmania), paratype of *B. tasmanica*, TM K226.

South Australia: Spencer Gulf - Boston I. (near Port Lincoln) (2) SAM E1401; at following islands in Banks Group, Marum I. (3) SAM E1475, (3) SAM E1492, Lushby I. (1) SAM E1488, Langton I. (1) SAM E1504, Hareby I. (1) SAM E1508; St Vincent Gulf - Edithburg jetty (near base of outer piles) (2) SAM E1403, (1) SAM E1457, (3) SAM 1458 (3) SAM E1502; Marino Rocks (3) SAM E1406; Aldinga Reef (1) SAM E1402; Victor Harbour - near Rosetta Head (3) SAM E1451, (3) SAM E1483, (3) SAM E1466, (5) SAM E1451, (3) SAM E1490 and near Whalers Wharf (3) SAM E1474; St Francis I. (Nuyts Archipelago) (4) SAM 1469.

Western Australia: Mistaken I. (King George Sound) (1) WAM 37-85; Garden I. (1) WAM 10-73; off Carnac I. (1) WAM 71-75; off Dunsborough (1) WAM 9-73; Houtman Abrolhos (At N. end of Morley I., Easter Group) (1) WAM 279-85.

Distribution

Known from south-western, southern and south-eastern Australia, from the Abrolhos I. in Western Australia to Sydney Harbour in New South Wales. Usually collected subtidally, occasionally intertidally. No records other than from Australia.

Habitat

'In South Australia individuals of this species live in crevices between rocks and under rocks in sheltered, calmer water where there is a deposition of fine, muddy silts, such as occurs on the lee side of the Bluff at Victor Harbour and at Edithburg jetty on Yorke Peninsula. The greatest concentration appears to be at the perimeter of the rubble-reef area, especially where the latter abuts open flat where sea-grasses grow. The proboscis extends only at night and then over the bottom adjacent to the burrow for a radius of about one metre' (N. Holmes pers. comm.).

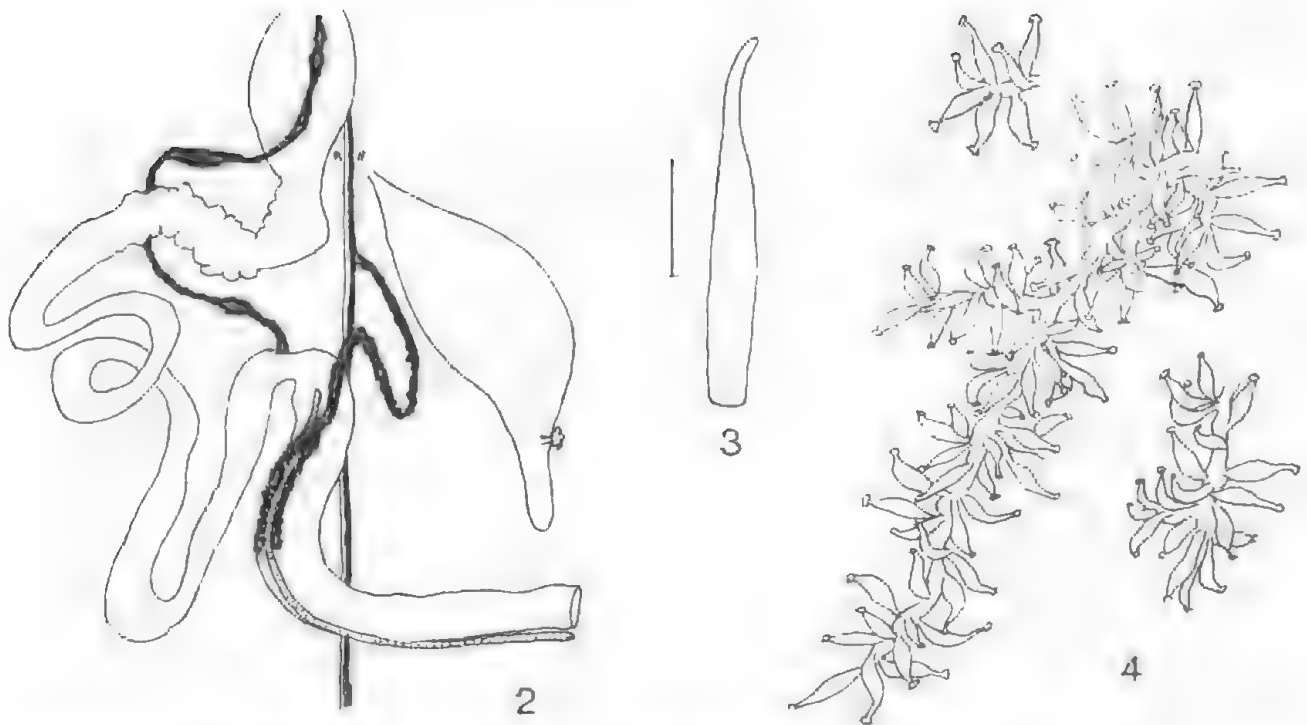
Genus *Pseudobonellia* Johnston & Tiegs

Pseudobonellia Johnston & Tiegs, 1919, pp. 213-230; Stephen & Edmonds, 1972, p. 401; Datta Gupta 1976, p. 115.

Type-species: *Pseudobonellia butlerina* Johnston & Tiegs

Diagnosis

Female with bifid proboscis. Trunk with two ventral setae. Two nephridia (gonoducts) with distally placed nephrostomes; nephrostomal lips crenated. Anal vesicles branching. Male carried in small blind tube that projects into coelom between nephridiopores. Type species: *Pseudobonellia*



FIGURES 2-4. *Metabonellia haswelli*. 2, anterior region dissected. 3, seta (scale line = 0.3 mm). 4, portion of anal vesicle.

biuterina Johnston & Tiegs, 1919. The genus contains only one species.

***Pseudobonellia biuterina* Johnston & Tiegs**
(Figs 5-8, 19)

Pseudobonellia biuterina Johnston & Tiegs, 1919, pp. 213-230, pls 9-11; Monro 1931, p. 33; Fisher 1948a, p. 856; Edmonds 1960, pp. 96-97, fig. 5; Stephen & Edmonds 1972, p. 401.

Archibonellia mjobergi Fischer, 1921, pp. 6-8; *Austrobonellia mjobergi* Fisher, 1948a, 856; Edmonds 1960, p. 97.

Holotype: AMS G477: type locality, North West Islet (Capricorn Group), Qu.

Description of female

Trunk: Small, maximum length 23 mm (mostly 6-14), maximum width 3-6, pyriform, sub-ovoidal to globular, pale to dark green. Body wall thin (sometimes transparent) except in anterior and posterior region, usually thinnest on dorsal side. Surface usually wrinkled by large numbers of closely set papillae. Nephridiopores and opening of male tube on antero-ventral surface often very noticeable.

Proboscis: Long, bifid, adherent and capable of much extension; in fixed specimens 1-10 times as long as trunk. Arms shorter (3-10 mm), normally about equal length. Ventral surface ciliated, lateral

edges tending to curve inwards. Mouth at base of proboscis.

Setae: Two (in addition smaller reserve setae usually present), golden brown, slightly iridescent, with free end forming a weak hook. Johnston and Tiegs state that larger hooks are 2-3 mm long and smaller 0.7-0.8 mm and that a strong muscle pad joins their internal ends 'evidently serving to impart to them a lateral pincer-like movement'. The description aptly fits the structure and function of an interbasal muscle. Although there are well developed setal muscles in the present specimens, none clearly show the presence of an interbasal muscle.

Nephridia (gonoducts or uteri): One pair, size variable, usually prominent, tapering distally, each with a slightly frilled, distally placed nephrostome borne on a short stalk. Largest eggs in nephridium 0.25-0.35 mm (Johnston & Tiegs 1919 give 0.11 mm). Nephridiopores on each side of nerve cord in anterior trunk region.

Male tube (androecium): Small, 1.5-3.0 mm long, opening externally near nerve cord at about level of nephridiopores. Opening often very noticeable. Tube encloses small, wormlike male attached to distal end of tube.

Alimentary Canal: Foregut short; midgut long, thin walled and associated for much of its length with an intestinal siphon; hindgut short. No precloacal caecum. Faeces form sub-ellipsoidal pellets.

Vascular System: Thin walled ventral vessel runs alongside of nerve cord. Thin walled dorsal blood vessel (fastened to foregut and body wall by mesenteries) fuses with gut near junction of fore- and mid-gut. Single neurointestinal vessel, arising from wall of midgut just posterior to anteriormost extremity of siphon, joins ventral vessel in anterior half of trunk. Intestinal extremity of neurointestinal vessel usually arises from two short roots which lie on each side of the siphon and in close contact with it. Neurointestinal vessel sometimes vesiculated.

Anal Vesicles: Two branching, tuft-like masses of fine tubes, arising on each side of posteriormost section of hindgut. In this respect they differ from the type description in which 'each anal tree consists of masses of very delicate, simple, cylindrical tubes opening separately into the rectum'. Edmonds (1960, p. 96) remarked that 'the anal vesicles do not seem to communicate with the cloaca as simply as described by Johnston and Tiegs' and that the tubes branch to some extent. The anal vesicles of dissected specimens in the present collection from Queensland and Western Australia are branched. In one of the paratypes (AMS G477), the vesicles arise from about 12 short tubes which branch and sometimes rebranch into simple cylindrical tubules that open to the coelom through slightly dilated funnels fringed with cilia.

Ovaries: Johnston & Tiegs (1919) state that the ovaries arise from the peritoneum lining the muscular strands that hold the posterior portion of the rectum in position and that they lie transversally on the frenulae. In the present specimens developing eggs lie more longitudinally in the posterior third or half of the body cavity in close association with the ventral vessel.

Description of male

According to Johnston & Tiegs (1919) the male lives permanently in the androecium of the female, the two being fused distally. Without definite mouth or anus, although a rudimentary canal is present. No setae. Two seminal vesicles present. How the male performs its sexual function is not known. Johnston & Tiegs (1919) suggest that 'the sperms may be liberated into the cavity of the androecium whence they reach the exterior through its canal and enter the adjacent openings. It is possible, however, that the male may be protruded through the canal of the androecium and actually liberate sperms in the female aperture'.

Systematics

Although the specimens examined in the present collection from North West I. and Heron I. differ in a few respects from the type description, they are considered to be *P. biuterina*.

No satisfactory character has been found that distinguishes any of the Western Australian

bonelliids from *P. biuterina*. Those collected from the CSIRO laboratory at Waterman Bay (from under pots standing on sand in an indoor aquarium through which sea water was continually passed) were pale green while those collected at Heron I. were dark green. How important colour differences are is not known. Agius & Jaccarini (1981) have shown that the unpigmented trochophores of *Bonellia viridis* when kept under constant illumination develop into unpigmented adults. Whether the depth of colour of *P. biuterina* depends on the amount of light received is unknown.

Two other bonelliids closely related to *P. biuterina* have been described from W.A., *Archibonellia michaelsoni* Fischer, 1919 and *Austrobonellia mjobergi* (Fischer, 1921), the former from Rottnest I., the latter from Broome, both localities being places where *P. biuterina* has been found. Both Fischer's species were described from single specimens.

Austrobonellia mjobergi Fischer, 1921, is now being placed in the synonymy of *P. biuterina* Johnston & Tiegs, 1919. Fischer described his specimen thus: trunk oval, 45 mm long, light grey and transparent; proboscis short, 18 mm long, with two arms of unequal length. Setae two with recurved tip, no interbasal muscle. Nephridia two, thin walled (containing eggs) with distally placed nephrostomes and a median, unpaired, smaller, thick-walled 'Segmentalorgan' or 'Uterus', with a basally placed nephrostome. Intestine long and convoluted. Anal vesicle disc-like and expanded with 12-15 dendritic main stems the branches of which possess lateral funnels.

If Fischer's 'Segmentalorgan' is a male tube and if injury accounts for the inequality in the length of the proboscis arms, then the description of *A. mjobergi* fits very well that of *P. biuterina*. Fischer's other specimen from W.A., *Austrobonellia michaelsoni*, differs in other characters and is possibly a separate species.

Specimens examined and localities (these are additional to those recorded in Edmonds, 1960)

Queensland: Heron I. (1) AMS W3719; North West I. (3) AMS W1807, (1) AMS W2691; Whitsunday Group (1) AMS W3029; One Tree I. (1) AMS W9275

Western Australia: Barrow I. (2) WAM 139-81; Riddell Pt, Broome (3) WAM 50-85; Roebuck Bay, Broome (2) WAM 47-85; Abrolhos I. (1) WAM 102-79; Yanchep Reef (2) WAM 98-79; Waterman Bay (CSIRO Marine Laboratory) (10) SAM E1439-1441; Garden I. (1) AMS W3720; Albany (S. side of Princess Royal Harbour) (2) WAM 147-81; Lookout Pt, Cheyne Bay (1) SAM E1482.

Distribution

Queensland: The Great Barrier Reef, from

Capricorn Group in the south to Low I. in the north.

Western Australia: From Barrow I. in the north to Cheyne Bay in the south. Whether the species extends from Queensland to Western Australia through Torres St is not known. It is not known from S.A., Vic., N.S.W. or Tas.

Other record: New Caledonia (Stephen 1976).

Habitat

Specimens have been collected intertidally in coral and limestone reefs; also from under stones and objects resting on sand.

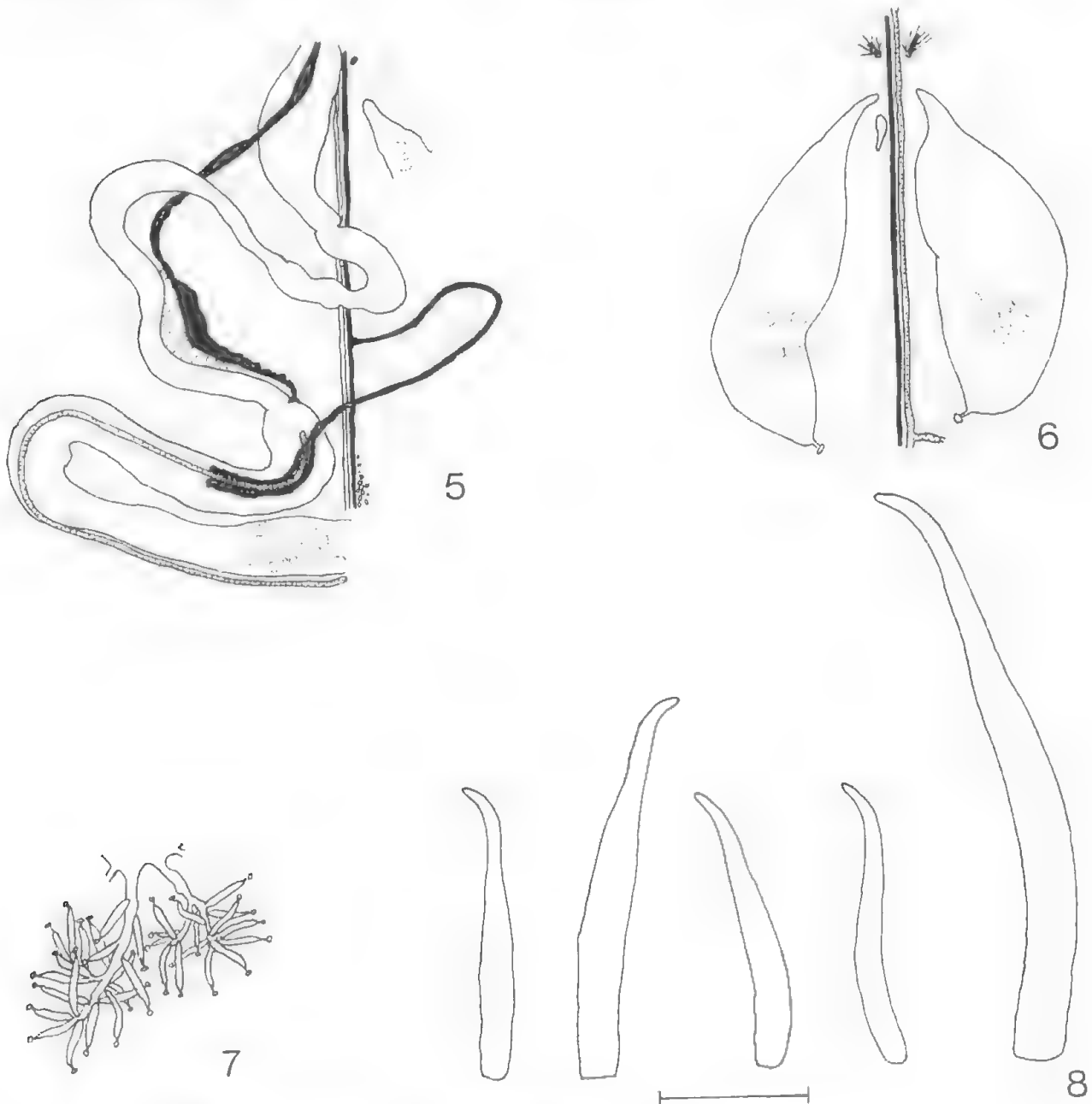
Genus *Archibonellia* Fischer

Archibonellia Fischer, 1919, p. 283; Fisher 1984a, p. 856.

Type-species: *Archibonellia michaelsoni* Fischer, 1919.

Diagnosis

Female with bifid proboscis. Trunk with two ventral setae. Three nephridia, two being paired, lateral and very small and the third median, large and unpaired. Position of nephrostome not known. Intestine very short with globular caecum. Male not described.



FIGURES 5-8. *Pseudobonellia biuterina*. 5, anterior region, digestive and vascular systems; 6, nephridia (gonoducts) and male tube; 7, small portion of anal vesicle; 8, setae from different specimens (scale line = 0.5 mm).

?* *Archibonellia michaelsoni* Fischer

Archibonellia michaelsoni Fischer, 1919, pp. 283–285; 1926, p. 207; Fisher 1948a, p. 856; Edmonds 1960, p. 97.

Type-specimen: Not known; type locality: west coast of Rottnest I., near Fremantle, W.A.

Description of female (after Fischer 1919) (Male not known)

Trunk: About 12 mm long, grey in life. Proboscis anteriorly forms two lappets. Setae two, with reserve pair and an interbasal muscle. Two small, paired nephridia ('Segmentalorgane') placed below a large unpaired 'Uterus'. Intestine very short, consisting of a single loop in anterior half of trunk and a bow-shaped tubular part in posterior half. Globular caecum present. Ovary lies along posterior region of nerve cord. Anal vesicles arise as single stems on either side of rectum and branch at tip. Position of nephrostome not known.

Systematics

A. michaelsoni resembles *P. biuterina* Johnston & Tiegs in many respects, especially in the possession of an unpaired, median 'Uterus' lying between paired lateral nephridia. Moreover, Fischer (1919) thought that he saw a male in the median structure. In *P. biuterina*, however, (1) the lateral nephridia are much larger than the medial tube; (2) the alimentary canal is very long and convoluted and not very short (incredibly short) as shown in Fischer 1919, fig. 6; and (3) neither caecum nor interbasal muscle is present. While the two species may be synonymous the described differences between them are considerable and until the type or more specimens became available it is probably best to consider them as different.

Genus *Protobonellia* Ikeda

Protobonellia Ikeda, 1908, p. 259; Fisher 1948a, p. 854; Datta Gupta 1976, p. 115.

Type-species: *Protobonellia mitsukurii* Ikeda, 1908.

Diagnosis

Proboscis of female long, tubular, non-bifid. Ventral setae two. One nephridium. Nephrostome stalked, fimbriated, basal. Anal vesicles long, dentritic. Male not known.

* *Protobonellia papillosa* Murina

Protobonellia papillosa Murina 1978, pp. 112–113, fig. 4.

Description (after Murina, 1978)

Trunk 28 mm long, 16 mm wide, bearing rounded papillae 0.25–1.25 mm in diameter, densest anteriorly and posteriorly. Proboscis light grey, width 5.5 mm, distally blunted; basal part (near mouth) has form of oval collar with thick, wavy, pigmented borders and two long processes laterally. Setae two, golden-yellow, bent or curved, 0.5 mm long, 0.15 wide. Nephridium single, rounded, lying on right side of nerve cord; nephrostome short, basal. Anal vesicles form dense bushes on each side of rectum. No clearly visible anal rosette.

Specimen and locality

Described from one female specimen collected during cruise of 'Dmitrii Mendeleef', Stn 1245, 30° 24' S, 161° 57' E near Lord Howe I. at 1200 m. No other record.

Genus *Sluiterina* Monro

Sluiterina Monro, 1927, p. 618; Murina 1976, p. 840.

Type-species: *Hamingia sibogae* Sluiter, 1902.

Diagnosis

Proboscis of female non-bifid; lateral edges turn inwards giving structure a tubular appearance; edges fuse near mouth to form a cup. Nephridium single, nephrostome basal. Anal vesicles bushy or brush-like. Male unknown.

* *Sluiterina alba* Murina

Sluiterina alba Murina, 1978, p. 111, fig. 3.

Description (after Murina 1978)

Trunk 44 mm long, 8 mm wide, posterior region damaged. Body wall white, thick and not transparent. Proboscis 12 mm long, 6 mm wide (distal part damaged), with lateral margins folded inwards making it tubular in form. Nephridium single, suc-like, 7 mm long, 3 mm wide, with centrally located nephrostome. About 50 white eggs with diameter 0.12–0.13 mm in cavity of body. Between posterior coils of gut are bunches of bright yellow material, probably remains of anal vesicles.

Specimen and locality

Described from a single female collected during cruise of 'Dmitrii Mendeleef', Stn. 1373, Great Australian Bight, 33° 48' S, 127° 07' E at 1080–1100 m. No other record.

Genus *Vitjazema* Zenkevitch

Vitjazema Zenkevitch, 1958, p. 195; Datta Gupta 1976, p. 115.

Type-species: *Vitjazema ultraabyssalis* Zenkevitch, 1958.

Diagnosis

Proboscis of female non-bifid; anterior region, however, expanded into a slightly widened 'head' with thickened festoons along anterior border; under festoons are triangular flaps directed inside a ventral gutter. Setae two. Nephridia two, nephrostome distal. Anal vesicles sac-like. No male known.

* *Vitjazema ultraabyssalis* Zenkevitch

Vitjazema ultraabyssalis Zenkevitch, 1958, pp. 195-197, fig. 3; Murina 1978, p. 115.

Description

Trunk green, length 14-15 mm. Proboscis 9-27 mm long with deep funnel on ventral side; anterior region widened with festoon-like border consisting of 5-6 triangular lappets. Setae 2, large with bent blades and blunt tips. Nephridia one pair, with distal nephrostomes at end of long tube. Anal vesicles unbranched, covered with small funnels.

Specimens and localities

Two female specimens collected during cruise of 'Dmitrii Mendeleef', Stn 1365, Great Australian Bight, 34° 25'S, 128° 12' 5"E at 3880 m.

Distribution

Kurile - Kamchatka Trench (at 5560-9700 m); Marianne Trench; Great Australian Bight (at 3880 m).

Genus *Zenkevitchiola* Murina

Zenkevitchiola Murina, 1978, p. 108.

Type-species: *Zenkevitchiola brevirostris* Murina, 1978.

Diagnosis

Proboscis long, non-bifid. Trunk without setae. Single nephridium, nephrostome basal. Anal vesicles, two, long, slender, filamentous. Male not known.

* *Zenkevitchiola brevirostris* Murina

Zenkevitchiola brevirostris Murina, 1978, pp. 108-109, fig. 1.

Description (after Murina, 1978)

Trunk 68 mm long, 28 mm wide, anterior third

and posterior quarter covered with low, rounded papillae 1.5 x 0.8 mm. Coils of gut visible through body wall. Proboscis white, transparent with lateral margins turned up or folded, length 65 mm, width 5-7 mm; distal extremity curved and widened, proximal extremity forms cup with a slit on ventral side. Nephridium single, 11 mm long, 5 mm wide, located on right side of nerve cord; anterior region swollen and filled with eggs 0.25-0.3 mm in diameter, posterior half with thicker walls and no eggs. Nephrostome basal, stalked and with rosette at distal end. Anal vesicles two, dark brown, tapering distally. Gut coils 10-12. Anus forms weak rosette, surrounded with small papillae.

Specimen and locality

Described from one female collected during voyage of 'Dmitrii Mendeleef', Stn 1345, near southern Tasmania, 43° 47'S, 147° 51'E at 755 m. No other record.

Genus *Anelassorhynchus* Annandale

Anelassorhynchus Annandale, 1922, p. 148; Fisher 1946, pp. 221-22; 1949, pp. 480-481; Stephen & Edmonds 1972, pp. 443-444.

Type-species: *Thalassema branchiorhynchus* Annandale & Kemp, 1922.

Diagnosis

Proboscis well developed, usually long, never bifid. One pair of ventral setae. Longitudinal, circular and oblique musculature of body wall continuous. Nephridia, 1-3 pairs, Nephrostomal lips long and spirally coiled (thus differing from genus *Thalassema*).

KEY TO AUSTRALIAN SPECIES OF *ANELASSORHYNCHUS*

1. Nephridia, two pairs and post-setal 2
Nephridia, three pairs and post-setal... *A. vegrandis*
2. Trunk globular to ovoidal, sandy-grey to light brown in colour *A. porcellus porcellus*
Trunk sausage-shaped to elongate, green in colour *A. porcellus adeluidensis*

Anelassorhynchus vegrandis (Lampert)

Thalassema vegrande Lampert, 1883, p. 341; Monro 1932, p. 33.

Anelassorhynchus vegrandis Fisher, 1946, p. 222; 1949, p. 481.

Type-locality: Philippines.

Description (after Lampert 1883)

Proboscis lacking. Nephridia three pairs and post-setal. Nephrostomal lips spirally coiled. Anal vesicles long and without ciliated funnels.

Remarks

Monro's specimen from the Barrier Reef was in poor condition and his identification was made with some reservation. The species is not well known.

***Anelassorhynchus porcellus porcellus* Fisher**
(Fig. 20)

Anelassorhynchus porcellus Fisher, 1948b, pp. 274-277, figs 1a-d; Edmonds 1960, pp. 91-92, pl. 1c.

Type-specimen: U.S. Nat. Mus., Washington D.C..
Type-locality: Honolulu, on reef south of harbour.

Description

Trunk: Globular to ovoidal, colour sandy grey to light brown, length 25-40 mm, maximum width 15-29 mm; skin rather thick but wrinkled with numerous flat papillae; musculature continuous. Setae two, golden-brown, lying posterior to mouth; no interbasal muscle present.

Proboscis: Fleshy, readily deciduate, usually tapering anteriorly, 8-20 mm long.

Alimentary Canal: Very long and fragile, filled with fragments of coral, small shells and coral sand (which usually rupture the thin gut wall as soon as one tries to free the intestinal coils); presiphonal section of mid-gut very long.

Vascular System: Consists of dorsal vessel, ring vessel, two neuro-intestinal vessels and a ventral vessel.

Setae: Two pairs, post-setal, with nephrostomal lips long, slender and coiled.

Anal Vesicles: Two long, with small, unstalked funnels. Intestinal siphon present but no precloacal caecum.

Systematics

The specimens from Heron I. correspond closely with two of Fisher's specimens of *A. porcellus* from Kakaoha Reef, Hawaii (U.S. Nat. Mus. part 26423). Fisher was unable to recognise any ciliate funnels on the anal vesicles of his specimens. In the Australian specimens the funnels, though small and sparse, are definitely present. One of Fisher's specimens when dissected was found to possess three pairs of nephridia.

Specimens Examined

Qu: Heron I. (Capricorn Group) (3) SAM E1425; North-West I. (Capricorn Group) (1) AMS W2816; Ingram I. (1) SAM E1431; Brockhurst Reef off Townsville (1) SAM E1494.

Distribution

Western Pacific Ocean at Hawaii and Great Barrier Reef, Qu.

***Anelassorhynchus porcellus adelaidensis* Edmonds**
n. stat.
(Figs 9-11, 21)

Anelassorhynchus adelaidensis Edmonds, 1960, pp. 92-93, pl. 2a.

Anelassorhynchus porcellus (in part) Edmonds, 1982, p. 316.

Type-specimen: AMS; type locality Aldinga Beach, S.A.

Description

A number of specimens which have previously been called *A. adelaidensis* and *A. porcellus* (in part) are now being referred to as a new subspecies, *A. porcellus adelaidensis*. The new subspecies differs from the nominate form in size, colour and distribution.

Trunk: More elongate than nominate subspecies, length 15-90 mm, maximum width 10-40 mm, always light to dark green, surface wrinkled and made verrucose by many, large, flat, white papillae (most numerous anteriorly and posteriorly); secretes copious amounts of mucus making animal very slippery to hold.

Proboscis: Fleshy, readily deciduate, up to 37 mm long, lateral edges may be wavy but never with processes.

Setae: Two golden brown, 2.8-5 mm long, no interbasal muscle (setae lost in some specimens).

Nephridia: Two post-setal pairs (occasionally an extra single nephridium or pair); nephrostomal lips filamentous, weakly to strongly coiled.

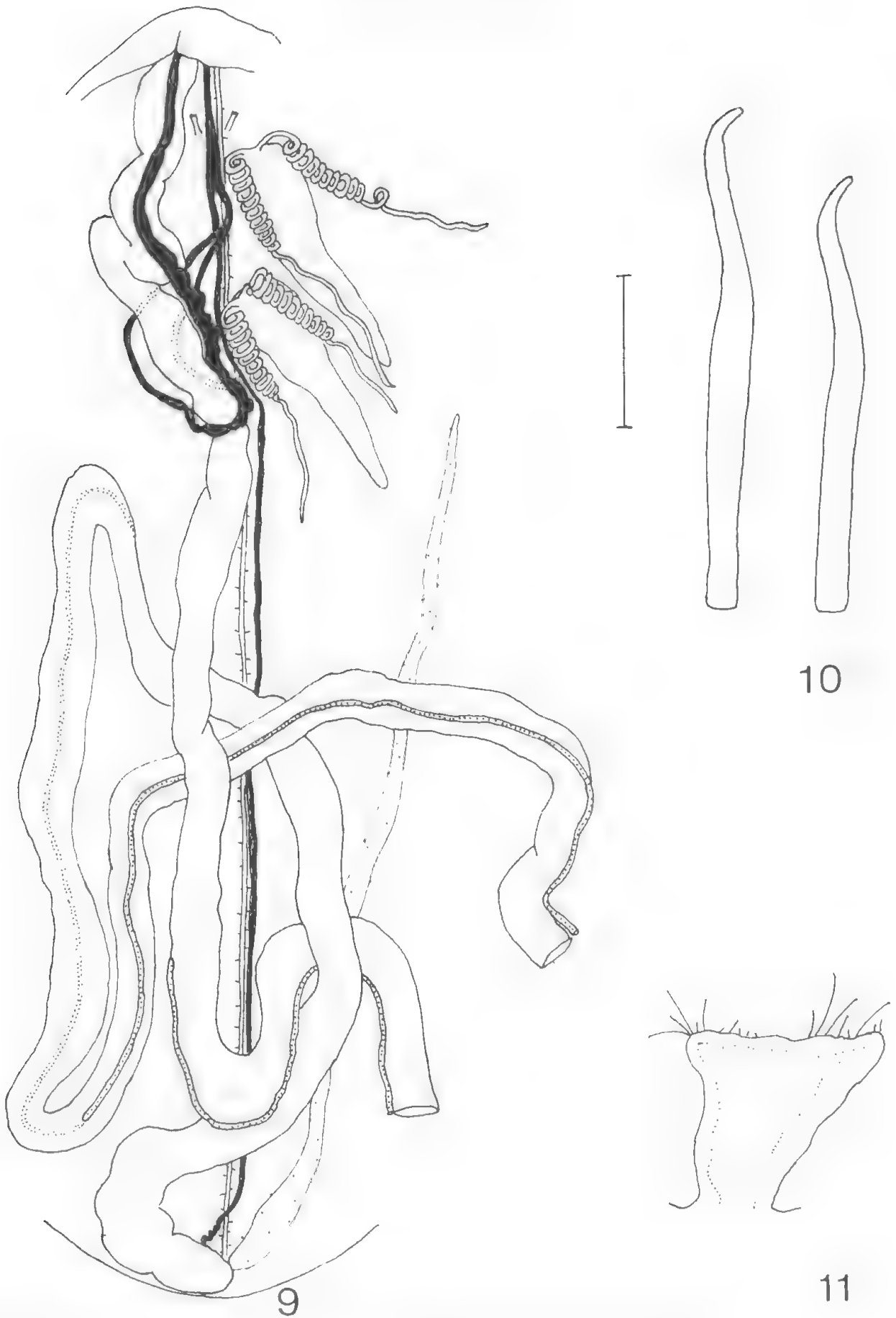
Alimentary Canal: Very long and much convoluted, with very long presiphonal section of mid-gut; faecal matter not in form of pellets; intestinal siphon present but no caecum.

Anal Vesicles: Two, long, thin walled, tubular but usually expanded basally, and attached (especially basally) to body wall by numerous mesenteries or muscles; coelomic surface bears sparsely distributed ciliate funnels and numerous brown spots which appear to be aggregates of very small pigmented granules.

Vascular system: Dorsal, ring, two neurointestinal- and ventral vessels. Hand cut sections of proboscis show two lateral and one median vessel. Well-developed ventral nerve cord extending into proboscis.

Specimens and localities

Victoria: Port Phillip Bay, SAM E1429, Brighton, SAM E1432.



FIGURES 9-11. *Anelassorhynchus porcellus adelaidensis*. 9, dissected specimen; 10, setae (scale line = 1.0 mm); 11, ciliated cup from anal vesicle.

South Australia: St Vincent Gulf-Port Willunga, SAM E1427 (1); Aldinga Reef, SAM E1428 (1); Cape Jervis, SAM E1430 (1); Coobowie, SAM E1454 (1), SAM E1455 (1), SAM E1456 (5), SAM E1461 (3), SAM E1462 (1); Brighton, SAM E1463 (5). Spencer Gulf-at following islands at Banks Group, Winceby I., SAM E1476 (3), Marum I., SAM E1477 (2), SAM E1486 (1), SAM E1493 (3), Lusby I., SAM E1489 (3). Eyre Peninsula-Port Lincoln, SAM E1479 (2); Port Turton Jetty, SAM E1503 (1); Venus Bay (under jetty), Blanche Pt (Streaky Bay), Smokey Bay, (coll. K. Gowlett-Holmes).

Systematics

The internal anatomy of the South Australian specimens corresponds very closely with that of *A. porcellus*. Their shape, however, is more elongate and their colour green. Fisher does not mention the colour of his specimens but specimens of *A. porcellus* collected by the author at Heron I., Qu., were light brown to sandy grey. The green subspecies is commonly collected by divers in S.A. but no brown forms have yet been found in the State. The distribution of the two subspecies consequently seems different. *A. gangae* Bisewar, 1984, recently described from Natal, South Africa and *A. porcellus adelaidensis* are closely related species.

Distribution

Southern Australia from Port Phillip Bay (Vic.) to Streaky Bay (Eyre Peninsula) in S.A.

Genus *Arhynchite* Sato

Arhynchite Sato, 1937, pp. 142-143; Fisher 1946, p. 485; Stephen & Edmonds 1972, p. 414.

Type-species: *Thalassema arhynchite* Ikeda.

Diagnosis

Proboscis long slender, often ribbon-like, sometimes deciduate; anterior extremity expanded into a fan-like structure. Two ventral setae with strong interbasal muscles. Nephridia two, with nephrostomal lips expanded into a leaf-like structure. Anal vesicles long, thin walled and unbranching. Vascular system with or without ring vessel.

Arhynchite hiscocki Edmonds

Arhynchite hiscocki Edmonds, 1960, pp. 90-91, fig. 3, pl. 1, fig. 1b; 1966, p. 178; Stephen & Edmonds 1972, p. 417.

Holotype: AMS W3714; type locality: Dunwich, Qu., 'dug from sand pit, 18" below surface'.

Description

Trunk: Elongate, slender, pencil-like, length 100-120 mm, width 4-6 mm, fixed specimens yellow-brown to grey green. Surface made verrucose by numerous near rows of elevated papillae, slightly larger at anterior and posterior extremities. Musculature continuous.

Proboscis: Delicate, slender, about 30 mm long, 1.5-2.5 mm wide, still attached to trunk in holotype; anterior extremity flattened and fan-like. In one specimen from Victoria proboscis is shorter, deciduate, with anterior extremity more spoon-like.

Setae: Two, connected to body wall internally by strong radiating muscles and to each other by strong interbasal muscle.

Nephridia: Two, sub-cylindrical, slender, length variable; post-setal. Nephrostome basal was expanded, frilled or leaf-like lip.

Alimentary Canal: Midgut with siphon; no precloacal caecum.

Vascular System: Dorsal blood vessel fuses with foregut at posterior extremity of latter; neurointestinal vessel connects with anterior section of midgut near anterior extremity of siphon. No ring vessel observed.

Anal Vesicles: Two, very slender, brown, about one third to a quarter as long as trunk, fastened throughout their length to posterior region of alimentary canal but to body wall over last quarter of their length. Numerous ciliated funnels scattered over their surface.

Systematics

Sato (1937) erected the genus *Arhynchite* for a group of echiurans lacking a proboscis. Fisher (1949), having found two species possessing a long deciduate proboscis, redescribed the genus. The proboscis of the holotype of *A. hiscocki* is still attached but that of one of the Victorian specimens is detached.

The genus contains six species collected from places bordering the Pacific Ocean: *A. californicus* - Monterey (U.S.A.), *A. inamoenus* - Monterey (U.S.A.), *A. pugettensis* Puget Sound (U.S.A.), *A. rugosus* - Shantung (China), *A. arhynchite* - Japan. Some of the species are closely related and difficult to distinguish. *A. hiscocki* is not a well known species and needs re-examination and revision when more species are found.

Specimens and localities

Queensland: Stradbroke I. (Edmonds 1960), AMS W3714 (2)

Victoria: Port Phillip Bay (Edmonds 1966) VM coll. (2)

South Australia: Spencer Gulf, north of Port Lowly, SAM E1524 (1).

Genus *Listriolobus* Spengel

Listriolobus Spengel, 1912, p. 316; Fischer 1926, p. 110; Fisher 1946, p. 233.

Type-species: *Listriolobus bahamensis* (Fischer), (designated by Fisher 1946).

Diagnosis

Proboscis of variable length, truncate but never bifid. Two setae with interbasal muscle. Longitudinal musculature of trunk wall grouped into bands (not always well developed in young specimens). Oblique musculature not banded or fasciculated as in *Ochetostoma*. Nephridia two to three pairs, nephrostomal lips long and spirally coiled. Anal vesicles sac-like to tubular and without branches.

KEY TO AUSTRALIAN SPECIES OF *LISTRIOLOBUS*

1. Longitudinal musculature in 7 bands *L. brevirostris*
Longitudinal musculature in 13 bands *L. sorbillans*

1* *Listriolobus sorbillans* (Lampert)

Thalassema sorbillans Lampert, 1883, pp. 340-341; Augener 1903, p. 349.

Listriolobus sorbillans Fisher, 1946, p. 234.

Type-locality: Philippines.

Australian record: Sydney (coll. Dr Schutte, 1876) in Augener 1903, p. 349.

Description (after Lampert 1883)

According to the type description (based on a single specimen) the trunk is 65 mm long and proboscis 24. Longitudinal musculature in 13 bands. Nephridia three pairs with spirally coiled nephrostomal lips, first pair presetal in position. Setae small. Anal vesicles long, brown, bearing microscopic ciliate funnels. Small rectal caecum.

Augener's description of his single specimen is brief. Trunk about 42 mm long, proboscis 18 mm. Whole body covered with papillae which are smallest in mid-trunk and largest posteriorly. Anal vesicles about two-thirds length of trunk.

Remarks

This Australian record needs confirmation. If the oblique musculature of Augener's specimen was fasciculated then it might have been *Ochetostoma australiense*.

Listriolobus brevirostris Chen & Yeh Chen-Chang (Figs 12-13, 22)

Listriolobus brevirostris Chen & Yeh Chen-Chang, 1958, pp. 273-278, fig. 7 A-D; Stephen and Edmonds 1972, p. 424.

Listriolobus bulbocaudatus Edmonds, 1963, pp. 243-244, pl. 1, fig. 1.

Type-locality: Kian-chow Bay, Shantung, China.

Description

Trunk: Sub-cylindrical to cigar shaped, length 21-85 mm, maximum width 10-20 mm, fixed specimens light to dark pink. Surface covered with white papillae, lying almost in rows. Posterior extremity may sometimes be modified and expanded into a fleshy, bulbous, conical structure bearing three or four rows of prominent, pointed or mamillate, white or pink papillae. Longitudinal musculature arranged in bundles, often difficult to discern externally. Dissected specimens show seven (eight in one specimen) well spaced longitudinal bands, occasionally weakly developed where the body wall is thin. Oblique musculature between bands of longitudinal musculature continuous and not in fascicles.

Proboscis: Non-deciduate in all specimens. In fixed condition short, stout, 10-16 mm long, 6-12 mm wide. Small papillae on dorsal surface. Lateral margins wrinkled, folded, indented or crenated. No lateral processes as in *Anelassorhynchus branchiorhynchus* Annandale & Kemp.

Setae: Two (with smaller reserve setae), length (measured in straight line from base to tip) up to 7.2 mm, strongly hooked and sickle-shaped. Strong interbasal muscle.

Nephridia: Two post-setal pairs; in one specimen three nephridia on one side and two on other. Length variable, some extending almost to posterior extremity of trunk. Nephrostomal lips long and much coiled.

Alimentary Canal: Long, much coiled. Presiphonal section of midgut long. Precloacal caecum present.

Vascular System: Dorsal vessel expands into a thin walled saccular vessel or heart. Well-developed ring vessel at junction of fore- and midgut gives off two neurointestinal vessels which join before they reach the interbasal muscle and then bifurcate to form a loop around the muscle. Ventral vessel pressed close to nerve cord and terminates in the cloacal caecum.

Anal Vesicles: Long, thin walled, brown, swollen basally in most specimens, bearing numerous, small, ciliated cups some on very short stalks. Anteriorly placed cups more sparsely distributed.

Systematics

These Australian specimens closely resemble *Ochetostoma septemyotum* Datta Gupta, Menon & Johnson, 1963 from Quillon, India. In none of the Australian specimens, however, has the oblique musculature of the body wall been found to form fascicles, like that shown for *Ochetostoma octomyotum* by Fisher 1946, pl. 23, fig. 2, and pl. 24 (in the spaces between muscles labelled MVL, ML and MDL) or like that shown in the transverse sections of *Ochetostoma bombayense* by Mathew 1976, fig. 5.

Because fasciculation of the oblique musculature is a character of *Ochetostoma*, the Australian specimens are considered different from *O. septemyotum*.

Edmonds (1963) originally described the specimens from Queensland as *Listriolobus bulbocaudatus*. At the time he was unaware of *L. brevirostris* Chen & Yeh Chen-Chang (1958) from Kiao-chow Bay, Shantung, China. At a later date Stephen and Edmonds (1972, p. 424) considered the two species were distinguished by three or four rows of prominent papillae and a bulbous structure both present at the posterior region of *L. bulbocaudatus*. More recently the author has examined three specimens from Queensland, in which the rings of prominent papillae and the bulbous structure are much reduced. This information brings the specimens within the range of *L. brevirostris*. Consequently *L. bulbocaudatus* is now considered to be a junior synonym of *L. brevirostris* Chen & Yeh Chen-Chang (1958).

Specimens examined and localities

Queensland: Yeppoon, SAM E1434 (1); Mud L., Moreton Bay, SAM E1433 (1); Round Is., Hervey Bay, SAM E1436 (1); Bramble Bay, SAM E1460 (1); ?Bramble Bay, SAM E1435 (4). Dredged from mud.

Distribution

China at Shantung. Australia: Queensland.

Genus *Ochetostoma* Leuckart & Rueppell

Ochetostoma Leuckart & Rueppell, 1828, pp. 7-8; Fisher 1946, p. 240; Stephen & Edmonds 1972, p. 426.

Type-species: *Ochetostoma erythrogrammon* Leuckart & Rueppell, 1828.

Diagnosis

Proboscis long, capable of much extension, non-bifid. Trunk medium to large with longitudinal musculature lying in well-defined bands. Intervals between bands crossed by numerous fascicles or small bundles of inner oblique musculature (Fisher



FIGURES 12-13. *Listriolobus brevirostris*. 12, anterior region dissected; 13, seta.

1946, pl. 23, fig. 2). Nephridia in one to seven pairs, with long spirally coiled nephrostomal lips. Setae two, with or without interbasal muscles. Anal vesicles long, more or less tubular, unbranched. Rectal caecum usually present.

KEY TO AUSTRALIAN SPECIES OF *OCHETOSTOMA*

- 1, Longitudinal musculature in 11-13 (11-14) bands; three pairs of nephridia, one pair presetal, two pairs postsetal. Fasciculation of oblique musculature usually well developed. No interbasal muscle *O. australiense*
- Longitudinal musculature in 17-19 (17-21) bands; two pairs of postsetal nephridia. Fasciculation of oblique musculature well developed. Strong interbasal muscle *O. haroni*

Ochetostoma australiense Edmonds (Figs 14-15, 23)

Ochetostoma australiense Edmonds, 1960, pp. 93-94, fig. 4, pl. 2b; Datta Gupta & Menon 1971, pp. 177-178, figs. 2c, 2e.

Type-specimen: AMS; type locality, mud flats at Dunwich (Stradbroke I.), Qu.

Description

Trunk: Usually large, sausage-like, cigar shaped or elongate, pale to dark red, length 40-130 mm, maximum width 15-30. Thickness of body wall variable, sometimes very thin. Surface, especially in anterior and posterior regions, covered by numerous small, flat, fleshy to wartlike papillae. Usually 12-13 (11-14) well developed longitudinal muscles best counted in dissected specimens. In 20 dissected specimens the maximum number of bands was 14 in 3, 13 in 10, 12 in 6 and 11 in one. Two

bands, one on each side of the nerve cord, lie very close together and may appear to be one. Oblique musculature between longitudinal bands usually grouped into numerous fascicles, which may be weakly developed or even absent in parts of some animals.

Proboscis: In living animals is highly extensible (150–200 mm), pale and ribbon-like. In fixed specimens shorter, fleshy, up to 60 mm long, with lateral margins rolled inwards on ventral side. Usually adherent or non-deciduate. Anterior extremity may be flattened somewhat and lateral margins may be slightly wrinkled. No lateral processes.

Setae: Two, 2.5–3.1 mm long (measured in a straight line from tip to midpoint of base), golden, encased in sheath connected to body wall by a number of setal muscles. No interbasal muscle.

Nephridia: Three pairs, the first presetal, others postsetal. Length variable, sometimes over half length of trunk. Nephrostomal lips elongate and spirally coiled, although sometimes only weakly. In one specimen only five nephridia present.

Digestive System: Mouth at base of proboscis. Foregut short, midgut very long and much coiled. Presiphonal section of midgut long and traversed for part of its length by ciliate groove. Siphonal section of gut also long. Well developed caecum present. Gut contents largely mud and sand; no faecal pellets.

Vascular System: Consists of dorsal blood vessel (sometimes well expanded), ring vessel or sinus (may also be expanded), two long neurointestinal vessels and a ventral blood vessel. Two neurointestinal vessels fuse to form one short vessel which joins the ventral vessel at about the level of the setae. Posteriorly ventral vessel gives off a branch to caecum.

Anal Vesicles: Two, long, slender, thin walled, light to dark brown, opening into cloacal region of intestine. Possess small, unstalked ciliate funnels.

Systematics

Edmonds (1960) considered these specimens with 11–14 muscle bands to be different from *O. erythrogrammon* Leuckart & Rueppell which possess 14–18 muscles. *O. erythrogrammon* and *O. australiense*, however, are closely related. The neurointestinal vessel of all the Australian specimens examined in the present study is double for most of its length. Datta Gupta & Menon (1971) state that the corresponding vessel in their specimens of *O. erythrogrammon* is single. If this difference always exists, it further distinguishes the two closely allied species. Sato (1939, fig. 9), however, shows two neurointestinal vessels for his specimens of *O. erythrogrammon*.

Stephen & Edmonds (1972) list nine species of *Ochetostoma* that possess three pairs of nephridia and in which the number of longitudinal muscles varies from 12 to 22. Wesenberg-Lund (1939) and Sato (1939) considered that they were conspecific. If they are correct then *O. australiense* would become *O. erythrogrammon*.

Specimens examined and localities

Queensland: Dunwich (in mud flats in front of cemetery) SAM E1410 (4) and E1411 (1); Caloundra (dug at low tides from mud flat; opposite a small mangrove island) SAM E1415 (7); Myora (in mud flats at low tide) SAM E1413 (20).

New South Wales: Goodwood I. (near mouth of Clarence River) AMS W3186, W3375, W3817; Brunswick Heads (1) AMS coll.

Habitat

At Goodwood I., the worms are found 'between high and low water marks in rather dark sand situated close to some small mangrove clumps. The proboscis is white and fleshy and protrudes from a hole in the sand. It lies along the surface of the sand and is about 6" long and 1/2" wide. In this condition it appears to be quite flat (like a ribbon) and does not appear to take on a tube-like shape as in preserved specimens. The body of the worm is soft and bright red in colour. Twelve longitudinal muscles show up clearly' (P. Durie pers. comm.)

Distribution

Eastern Australia from Caloundra (Qu.) to Goodwood I. (N.S.W.). Andaman I. (Datta Gupta & Menon, 1971). An inhabitant of intertidal mud flats.

Ochetostoma baronii (Greeff)

(Fig. 24)

Thalassema baronii Greeff, 1879, pp. 141–152, pl. 6, figs 62–67.

Ochetostoma baronii Mackie, 1961, p. 247; Stephen & Edmonds 1972, p. 429; Amor 1976, p. 123–124. *Ochetostoma myersae* Edmonds, 1963, pp. 245–246, pl. 1, fig. 2.

Previous Australian record: N.S.W. (Edmonds 1963).

Description

Trunk: Small to moderately large, sac-, sausage- or cigar-shaped, length 21–70 mm, maximum width 9–25 mm; anterior region rounded, posterior sometimes almost pointed. Green. Surface covered with soft, almost white, slightly elevated, wart-like papillae, largest in posterior region of trunk. Longitudinal musculature in 18–19 (21 in one specimen) bundles. Oblique musculature between

longitudinal muscles forms fascicles which sometimes are only weak.

Proboscis: In preserved specimens about half to fifth length of trunk, either deciduate or non-deciduate. Lateral margins tend to roll inwards so as to form a tube. Plump and almost conical in largest specimen.

Setae: Two, up to 3.1 mm long, golden, connected by strong interbasal muscle.

Alimentary Canal: Mouth at base of proboscis. Gut much coiled and filled with coral and shell fragments; obviously animal is able to ingest larger particles than *Ochetostoma erythrogrammon* and *Bonellia viridis* (Chuang 1962, Jaccarini & Schembri 1977).

Nephridia: Two post-setal pairs, nephrostomal lips long, weakly or strongly coiled. Largest ova 0.09–0.11 mm in diameter.

Anal Vesicles: Two, very large, slender, tapering distally and bearing numerous, small, brown unbranched ciliate cups or funnels.

Vascular System: Dorsal blood vessel, ring vessel, two neuro-intestinal vessels and ventral vessel. Neurointestinal vessels long but fusing to form one short vessel which joins ventral vessel at about level of setae.

Systematics

Ochetostoma myersae Edmonds, 1963, was described from N.S.W. as possessing 18–21 longitudinal muscles, two pairs of post-setal nephridia and unbranching ciliate funnels. At the time the species was considered to be different from *O. baronii* (Greeff) in which the ciliate funnels were described as being branched, a fact confirmed by Fischer (1895: 19).

Amor (1976, p. 123), however, after studying specimens collected at Canary Is (type locality), Brazil and Galapagos Is. found that 'amongst the 38 specimens examined there did not exist any branched outgrowths in the anal vesicles'. The examination of three specimens of *O. baronii* from Arrecife, Canary Is, collected by A.K. Totten and identified by A.C. Stephen (B.M. 11.7.7.37), confirms Amor's finding that the funnels are unbranched.

In view of this evidence (especially as Amor examined 38 specimens) the statements of Greeff and Fischer about the branching of the ciliate funnels are questionable. Consequently the chief reason given by Edmonds (1963) for separating *O. myersae* and *O. baronii* is now invalid and *O. myersae* becomes a junior synonym of *O. baronii*. Amor (1976: 123) also considers *O. edax* Fisher, 1946 and *O. kefersteini* (ten Broeke, 1925) as junior synonyms of *O. baronii*.

O. punicea (Dartnall, 1976) is very closely related to *O. baronii* if the ciliated funnels of the latter are unbranched. *O. punicea* has 18–19 longitudinal

muscles, fasciculated oblique musculature, setae about 2.25 mm long, two pairs of post-setal nephridia with spirally coiled lips and anal vesicles with unbranched ciliate cups. No interbasal muscle, however, is present and the left anal vesicle is not symmetrically placed in relation to the right. Whether the last character is taxonomically significant is doubtful. The species was described from Great Tulear Reef, off south-west Madagascar.

Specimens examined and localities

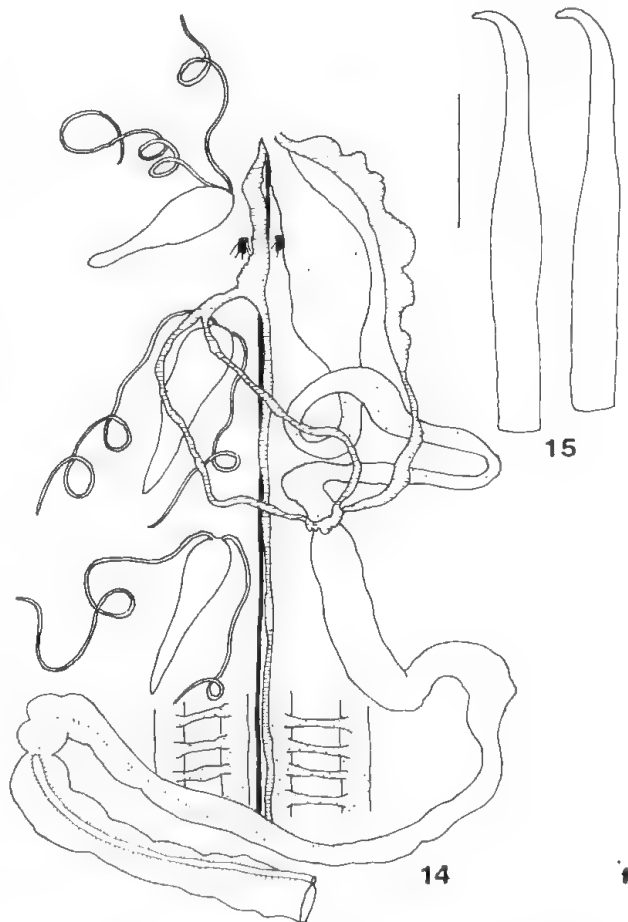
New South Wales: Long Reef (near Sydney) (1) AMS 3357; Collaroy, AMS W3368 (1); Minnie Waters, 'intertidal region of low tide' AMS coll. (1).

Queensland: Bird I. (Moreton Bay) (1) SAM E1417.

Distribution

Eastern Australian from Sydney (N.S.W.) to Moreton Bay (Qu.).

Extra Australian, wide: Atlantic Ocean (Canary I., Bermuda, West Indies, Senegal, Florida, Brazil); Indian Ocean (Zanzibar, Amboina); Pacific Ocean (Papua, Loyalty I., Galapagos).



FIGURES 14–15. *Ochetostoma australiense*. 14, anterior region dissected; 15, setae (scale line = 1.0 mm).

Genus *Thalassema* Lamarck

Thalassema Lamarck, 1801, p. 28; Fisher 1946, p. 230; Stephen & Edmonds 1972, p. 452.

Type-species: *Lumbricus thalassemus* Pallas, 1776 = *Thalassema thalassemus* (Fisher, 1946).

Diagnosis

Echiuridae with well developed, long, non-bifid but usually truncated proboscis. Two ventral setae; lacking anal setae. Longitudinal, circular and oblique musculature continuous. Nephridia in one or two pairs; nephrostome basal and nephrostomal lips neither elongated nor spirally coiled.

Thalassema sydniense Edmonds
(Figs. 16-17)

Thalassema sydniense Edmonds, 1960, p. 89-90, figs. 1-2, pl. 1a.

Holotype: AMS G11219; off Watson Bay, Sydney, N.S.W.

Description (based on four specimens reported in Edmonds, 1960 and two additional ones)

Trunk: Small, grey-brown, sausage to sub-ovoidal; length 2.5-8 mm (most about 5), width 1-2.7. Surface covered with papillae, lying almost in rows and largest posteriorly. Musculature continuous.

Proboscis: Firmly attached, as long as trunk or less, becoming narrower anteriorly.

Setae: Two, golden brown, 1.0-1.1 mm long, with strongly recurved tip; strong interbasal muscle and well developed system of setal muscles.

Nephridia: Two pairs, post-setal. Nephrostome on short stalk near proximal extremity of nephridium; lips expanded but not elongate or spirally coiled. One specimen with only 3 nephridia.

Alimentary Canal: Very long, intestinal siphon present but no caecum.

Anal Vesicles: Two, expanded towards base; surface with ciliated cups.

Systematics

These specimens resemble *Thalassema steinbecki* Fisher, 1946, which occurs along the Pacific coast of North America from California to Ecuador and which has also been reported from the Indian Ocean (Datta Gupta 1975). *T. sydniense* differs from *T. steinbecki* because its nephrostomes are on short stalks or peduncles. *T. sydniense* is known only from six specimens, four of which are very small. It is not a well known species and needs redescription when more specimens become available. Whether the species is a small one or

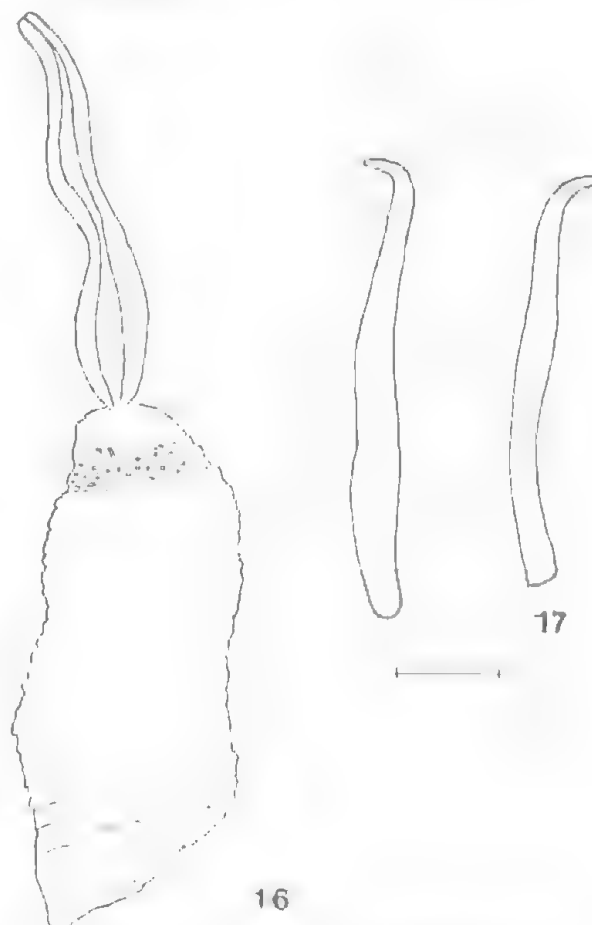
whether the specimens so far collected are simply small ones is not known.

Specimens examined and localities

New South Wales: Watson Bay, AMS G11219 (4).

Victoria: 40° 39'0"S, 144° 56'E (Bass St Survey) MV G3386 (2).

No other records.



FIGURES 16-17. *Thalassema sydniense*, 16, entire animal (scale line = 1.00 mm); 17, seta (scale line = 0.25 mm).

Genus *Ikeda* Wharton

Ikeda Wharton, 1913, pp. 260-261; Fisher 1946, pp. 220; Stephen & Edmonds 1972, pp. 471-472.

Type-species: *Thalassema taenioides* Ikeda, 1904.

Diagnosis

Trunk very long with longitudinal musculature thickened to form bands. Proboscis very long, non bifid. Nephridia very numerous and unpaired.

Ikeda sp.

The very long proboscis of an echiuran has been noticed and collected a number of times by divers

in St Vincent Gulf, S.A. [Edmonds 1982, pl. 23 (4)]. They report that the organ is able to extend for more than 1.5 m. The echiuran itself, however, has proved very difficult to collect on account of the depth of its burrow and the problem of digging in sand at depths of 6-10 m. So far only one specimen has been collected. Unfortunately, it was considerably damaged so that only a limited amount of information can be given about it. Several intact probosces of other specimens have been collected.

The worm resembles in some respects *Ikeda taenioides* (Ikeda, 1904), known from six Japanese specimens. A specific identification of the specimen from S.A. is not possible on account of the damage to its nephridial and anal regions. I am, however, tentatively assigning it to the genus *Ikeda*.

Description

Trunk: Long, slender, worm-like, rather flat in preserved condition; 290 mm long, 7-11 mm wide, pinkish-brown when collected but dark brown when fixed. Longitudinal musculature grouped in 5 bands prominent externally; numerous small sub-globular papillae cover surface of much of trunk.

Proboscis: Flat, about 400 µm long, 5-10 wide, with margins in fixed specimens slightly frilled; one surface cream-brown in colour marked with almost transverse brown-black stripes; posterior region of proboscis (near mouth) modified to form cup-like structure.

Setae: Two, about 10 mm long, with well developed setal muscles. Nephridial region much damaged.

Anal Vesicles: Missing.

Alimentary Canal: Very long and convoluted. Some eggs with maximum diameter 0.35-0.38 mm entangled in gut.

Specimens examined and localities

'Kemps Ground', off Glenelg, St Vincent Gulf, S.A., at 9-10 m, 13 March, 1986, one spec. coll. N. Holmes and S. Parker; SAM E1509; separate probosces of other specimens SAM E1587. Coffin Bay (near Black Springs), Eyre Peninsula, S.A. (probosces only).

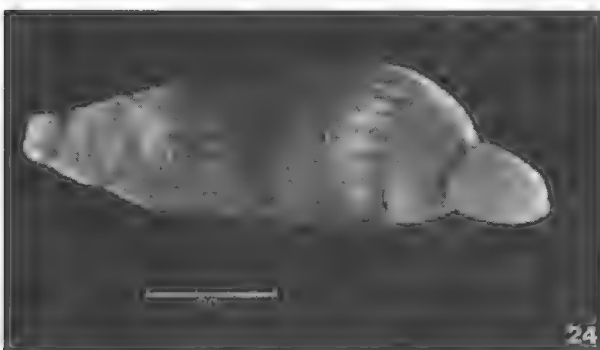
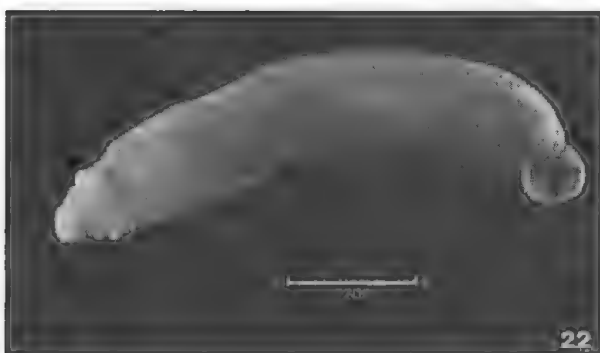
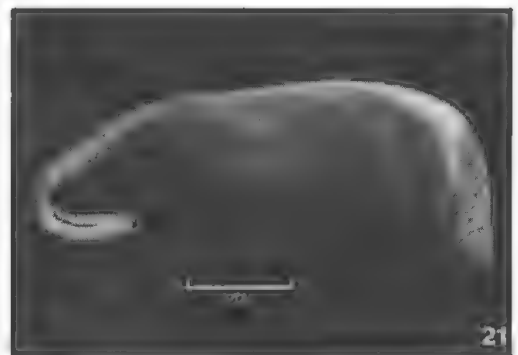
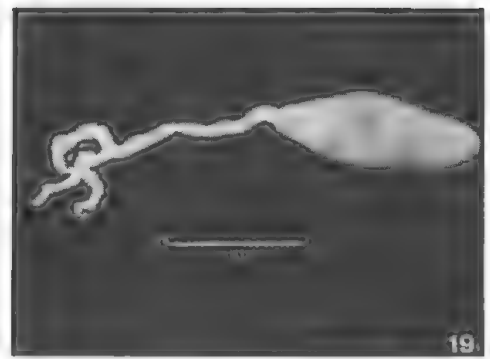
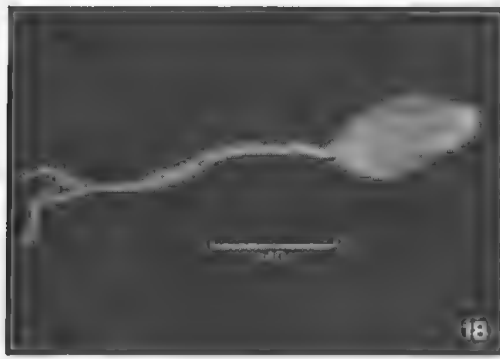
ACKNOWLEDGMENTS

Thanks are due to the following for help with specimens: from W.A., Mrs L. Marsh, Mrs S. Slack-Smith, Dr E. Hodgkin and Dr B. Wilson; from S.A., I.M. Thomas, Mrs K. Gowell-Holmes, N. Holmes, Miss H. Kald and W. Zeidler; from Vic., Dr B. Smith and Mrs H. Black; from Tas., Dr A. Dartnell and Dr A. Green; from N.S.W., Dr P. Hutchings, Miss P. Wearne, Miss E. Pope and Miss E. Bennett; from Qu., Prof W. Stephenson, W. Green, S. Cook, O. Kelly and Mrs M. Specht. Mr P. Kempster (University of Adelaide) took the photographs and Dr I. Beveridge (Institute of Medical and Veterinary Science, Adelaide) made sections of the body wall of one species. Mr R. Sims and Mr E. Easton (British Museum of Natural History, London) and Dr M. E. Rice (Smithsonian Institute, Washington D.C.) kindly sent specimens on loan. Dr E. Matthews (SAM) helped with translations from Russian.

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FIGURES 18-24. 18, *Metabonellia haswelli*; 19, *Pseudobonellia biuteringa*; 20, *Anelassorhynchus porcellus porcellus*; 21, *Anelassorhynchus porcellus adalaidensis*; 22, *Listriolobus brevirostris*; 23, *Ochetostoma australiense*; 24, *Ochetostoma baroni*.

FURTHER OBSERVATIONS ON PENTATOMIDS (ARTHROPODA) PARASITIC IN AUSTRALIAN REPTILES AND MAMMALS

BY J. RILEY & D. M. SPRATT

Summary

A collection of adult and nymphal pentastomids representative of at least four genera is described. Two species of *Raillietiella* and one species of *Parasambonia* from snakes (*Pseudechis australis*, *Pseudonaja textilis* and *Cryptophis nigrescens*) are probably new, but more specimens are required before their status can be confirmed. Mature and immature *Waddycephalus longicauda*, *W. superbus* and *W. punctulatus* (all Riley & Self 1981) are identified from snake hosts but specific determination of five lots of specimens was not possible. Evidence endorses an earlier suggestion that there may be two species of *Waddycephalus* in tiger snakes ; *W. scutata* from island populations and an unnamed species from mainland populations of the *Notechis scutatus/ater* complex. Nymphal specimens of *Waddycephalus* from marsupials (*Parantechinus apicalis* and *Dasykaluta rosamondae*), a snake (*Cryptophis nigrescens*), a gecko (*Heteronotia binoei*), a skink (*Hemiergis decresiensis*) and frogs (*Ranidella remota* and *Palmatorappia solomonis*) all bear characteristic double hooks. The accessory spine above the hook arises from a point midway between the hook and the fulcrum and appears to be an integral and functional part of the hook. *Armillifer australis* Riley & Self 1981 is described from infections in four pythons (*Morelia amethystina* and *Morelia spilota*) ; the latter is a new host record. A single nymph recorded from the body cavity of *Rattus leucopus* is identified as *A. australis* on the basis of abdominal annulus counts.

FURTHER OBSERVATIONS ON PENTASTOMIDS (ARTHROPODA) PARASITIC IN AUSTRALIAN REPTILES AND MAMMALS

J. RILEY & D. M. SPRATT

RILEY, J. & SPRATT, D. M. 1987. Further observations on Pentastomids (Arthropoda) parasitic in Australian reptiles and mammals. *Rec. S. Aust. Mus.* 21(2): 139-147.

A collection of adult and nymphal pentastomids representative of at least four genera is described. Two species of *Railietiella* and one species of *Parasambonia* from snakes (*Pseudechis australis*, *Pseudonaja textilis* and *Cryptophis nigrescens*) are probably new, but more specimens are required before their status can be confirmed. Mature and immature *Waddycephalus longicauda*, *W. superbus* and *W. punctulatus* (all Riley & Self 1981) are identified from snake hosts but specific determination of five lots of specimens was not possible. Evidence endorses an earlier suggestion that there may be two species of *Waddycephalus* in tiger snakes; *W. scutata* from island populations and an unnamed species from mainland populations of the *Notechis scutatus/ater* complex. Nymphal specimens of *Waddycephalus* from marsupials (*Parantechinus apicalis* and *Dasykaluta rosamondae*), a snake (*Cryptophis nigrescens*), a gecko (*Heteronotia binoei*), a skink (*Hemiergis decresiensis*) and frogs (*Ranidella remota* and *Palmatorappia solomonis*) all bear characteristic double hooks. The accessory spine above the hook arises from a point midway between the hook and the fulcrum and appears to be an integral and functional part of the hook. *Armillifer australis* Riley & Self, 1981 is described from infections in four pythons (*Morelia amethistina* and *Morelia spilota*); the latter is a new host record. A single nymph recorded from the body cavity of *Rattus leucopus* is identified as *A. australis* on the basis of abdominal annulus counts.

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In an historical review of Australian Pentastomida, Riley, Spratt & Presidente (1985) recorded seven genera comprising 17 species occurring in Australian reptiles and mammals, and identified nymphal *Waddycephalus* spp. and *Armillifer* spp. from marsupials. This paper reports primarily on a pentastomid collection in the South Australian Museum (SAM) and describes further adult and nymphal material, attributed to the genera *Waddycephalus* and *Armillifer*, from reptiles, amphibians and mammals. The double nature of the hook of nymphal *Waddycephalus* (Riley *et al.* 1985) is confirmed, as are earlier observations (Riley & Self 1981b) of significant anatomical differences between mainland and island forms of *Waddycephalus* infecting the same species of snake. Two large railietiellids and two parasambonids from snakes are described, however more material is required before their specific status can be confirmed as new.

MATERIALS AND METHODS

The material examined in this study was collected primarily in eastern mainland Australia, Tasmania and neighbouring offshore islands. It is supplemented by nymphal *Waddycephalus* (or

Elenia?) spp. from the Solomon Islands and New Guinea.

The methods are those outlined in Riley *et al.* (1985) and the hooks of railietiellids were measured according to the convention of Ali *et al.* (1982) i.e. barb length AB (notation AD in error, p. 42, Riley *et al.* 1985), shank length BC. Overall hook length of the double hooks of nymphal *Waddycephalus* spp. was measured according to the convention illustrated in Figure 2. All measurements are in micrometers with the exception of body length, which is in millimetres. Most specimens are deposited in the South Australia Museum (SAM), Adelaide; two lots are deposited in the Queensland Museum (QM), Brisbane. Reptile nomenclature follows Cogger, Cameron & Cogger 1983; dasyurid marsupial nomenclature follows Archer 1982.

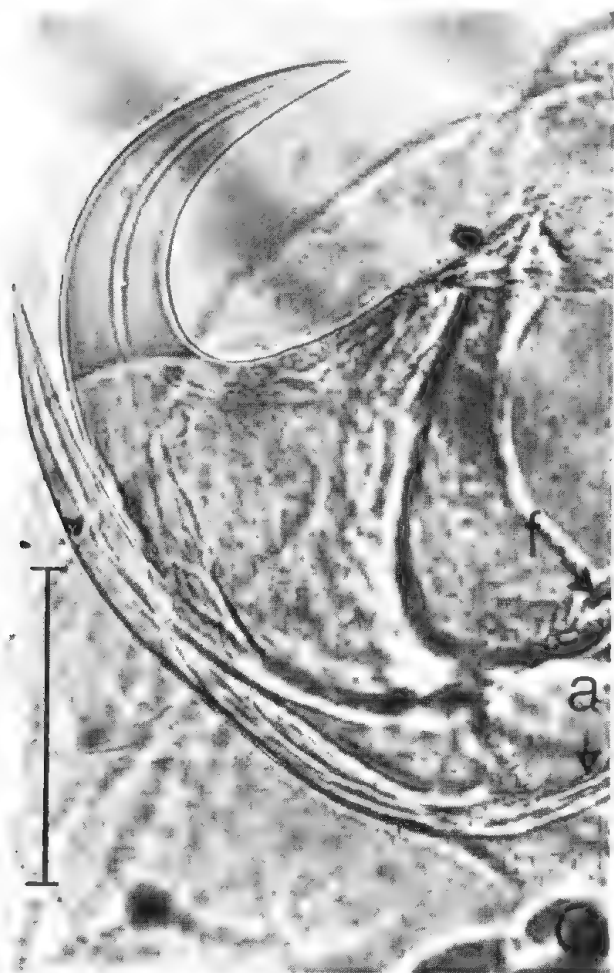
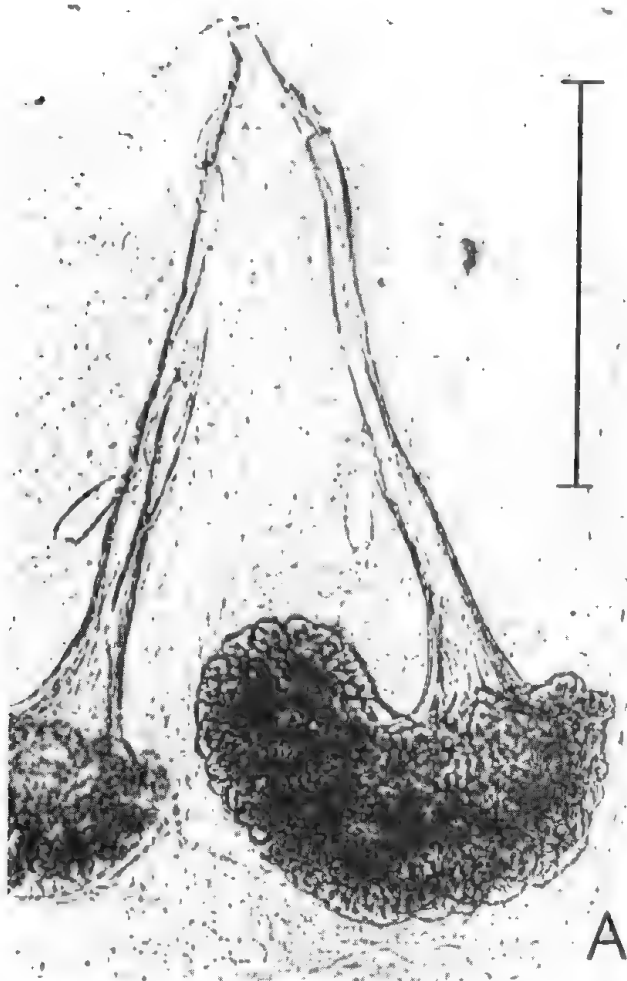
Order CEPHALOBAENIDA

Railietiella spp. from snakes

Railietiella sp. a

Material Examined

From lung of *Pseudechis australis* (Gray), locality unknown (died in Melbourne Zoo), in SAM No. N1980183.



Description

Female ($n = 4$). Length 33–52 ($\bar{x} = 42$), with 45 or 6, 41 or 2, 36 (?) and 39 (?) annuli respectively. Posterior hook of 52 mm specimen, AB 240, BC 370.

Male ($n = 1$). Length approx. 9, annuli uncountable and therefore slide-mounted. Posterior hook, AB 135; BC 220. Base of copulatory spicule massive, maximum diameter 520 and covered with a reticulum of tubular elevations (Fig. 1A).

Discussion

The heavily ornamented male spicule, 520 μm across at the base (Fig. 1A), is virtually identical to those of *R. orientalis* and *R. agcoi* (Ali, Riley & Self 1982). *R. orientalis* infects colubrid, viperid and elapid snakes in south-east Asia and Taiwan whereas *R. agcoi* is found only in cobras in the Philippines. The females of these two species are distinguished in a number of ways: the former has bigger hooks (see Fig. 3, in Ali *et al.* 1982), more annuli (33–47 *contra* 30–35) and is generally longer and stouter than *R. agcoi*. The overall shape of the present species, and its hooks, are reminiscent of *R. agcoi* but its annulus count, though variable, is within the range of *R. orientalis*. The host, the king brown snake, *Pseudechis australis*, is an endemic species and its raillietiellid parasite may be unique by virtue of geographic isolation. This is probably a new species, but, because it combines important characteristics of these two closely related species we have left it unnamed, pending more specimens and more refined diagnostic techniques.

Raillietiella sp. b

Material Examined

From lung of *Pseudonaja textilis* (Duméril, Bibron & Duméril), Townsville, Queensland, in SAM No. N1985149.

Description

Female ($n = 2$). One headless abdomen; length other specimen 50, annuli uncountable, specimen therefore slide-mounted. At least 30–40% of eggs in uterus contain fully-developed primary larvae; the specimen is therefore mature. One posterior hook measured, AB 400; BC 510.

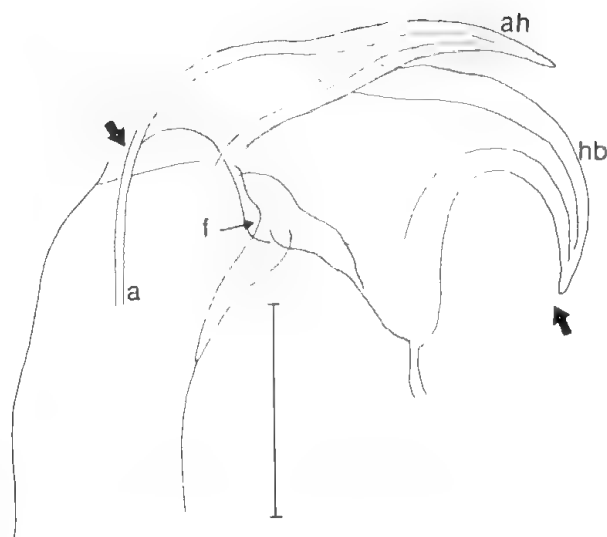


FIGURE 2. Diagrammatic representation of hook of nymphal *Waddycephalus* sp. The distance between the larger arrows indicates our measurement of the overall length (a = apodeme; ah = accessory hook; f = fulcrum; hb = hook barb) (scale bar = 120 μm).

Discussion

Apart from the species recorded above, only two raillietiellids are known from Australia; *R. amphiboluri* from the bearded dragon, *Amphibolurus barbatus* (Cuvier), (Mahon 1954, Riley *et al.* 1985) and *R. scincoides* from the eastern blue-tongued lizard, *Tiliqua scincoides* (White), (Ali, Riley & Self 1984); the latter has blunt-tipped posterior hooks and *R. amphiboluri* is smaller than the present species with much smaller hooks (AB 200–220; BC 370) (Ali *et al.* 1985) (notation AD in error).

The intact specimen clearly belongs to the Group VI taxon of raillietiellids (Ali *et al.* 1985) which includes all of the species from snakes. The two species, *R. orientalis* from south-east Asia and Indonesia and *R. agcoi* from the Philippines are, zoogeographically, most proximate to the present specimen, but it has much longer hook barbs (dimension AB) than either of these species (compare with Fig. 3 in Ali, Riley & Self 1982). This is almost certainly a new species but the poor state

FIGURE 1. A. Copulatory spicules of male *Raillietiella* sp. from *Pseudechis australis* showing massive base covered with tubular elevations (scale bar = 500 μm). B. Cephalothorax of male nymph of *Waddycephalus* sp. from mesentry of *Satanellus hallucatus* [described by Riley *et al.* (1985)]. The double nature of the outer hooks is obvious but the inner hooks are not in the plane of focus (m = mouth) (scale bar = 500 μm). C. Outer hook of nymph of *Waddycephalus* sp. from *Hemiergis decresiensis* showing spinous extension. The back of the extension forms a long apodeme (a) (f = fulcrum) (scale bar = 100 μm). D. Hook of adult *Armillifer* sp. from python (S.A.) illustrating typical unornamented porocephalid hook (a = apodeme; f = fulcrum) (scale bar = 200 μm).

of preservation and lack of males precludes specific identification.

Order POROCEPHALIDA

Parasambonia spp. from snakes

Parasambonia bridgesi Riley & Self

Material Examined

From lung of *Pseudechis porphyriacus* (Shaw), Healesville Sanctuary, Victoria, in SAM No. N1980173.

Description

Female ($n = 2$). Length 26, with 50 and 54 pre-vaginal and post-vaginal annuli.

Male ($n = 1$). Length 7, with 53 annuli.

Discussion

There are no uncertainties regarding the status of these specimens. All of the characters fall well within the ranges described for *P. bridgesi* by Riley & Self (1982).

Parasambonia sp. a

Material Examined

From lung of *Austrelaps superbus* (Günther), 5 km south of Bowral, New South Wales, in SAM No. N1986192.

Description

Male ($n = 1$ plus 2 anterior ends). Length 8, with 51 annuli. Heads slide-mounted, outer hook with finger-like extension, AD 175, 190; BC 95, 100.

Discussion

The outer hooks possess the projecting spine characteristic of the genus *Parasambonia*. The low annulus count is more characteristic of *P. minor* than *P. bridgesi*, however the hook dimensions are much smaller than those of *P. minor*, the dimensions of which do not overlap with the much larger hooks of *P. bridgesi* (Riley & Self 1982). The absence of fully gravid females precludes confident specific identification. *P. minor*, but not *P. bridgesi*, has been recorded from the copperhead (Riley & Self 1982).

Parasambonia sp. b

Material Examined

From lung of *Cryptophis nigrescens* (Günther), Mogo S.F., New South Wales, in SAM No. N1986191.

Description

Female ($n = 1$). Length 29, annuli uncountable. Outer hook with projecting spine, AD 465; BC 245.

Discussion

Hook dimensions in this gravid specimen are larger than those reported in species of *Parasambonia* from Australian snakes (Riley & Self 1982), suggesting that it represents a new species. Additional specimens in good condition are required to resolve this matter. The stomach of this small-eyed snake contained a partly-digested eastern water skink, *Sphenomorphus quoyii* (Duméril & Bibron).

Waddycephalus spp. from snakes

Waddycephalus longicauda Riley & Self

Material Examined

From lung of *Demansia psammophis* (Schlegel), Queensland National Parks and Wildlife Service, Moggill, Queensland, in QM No. W12193.

Description

Female ($n = 1$). Length 27, with 49 pre-vaginal and 7 post-vaginal annuli, preadult.

Male ($n = 6$). Length 8–11, with 56–59 annuli ($\bar{x} = 57$).

Discussion

The features of this material, particularly the long and finely tapered post-vaginal tail, are characteristic of *W. longicauda* (Riley & Self 1981b).

Waddycephalus sp. a

Material Examined

From lung of *Pseudonaja textilis* (Duméril, Bibron & Duméril) taken at Halls Gap, Grampians, Victoria, in SAM No. N1980204.

Description

Female ($n = 1$). Length 37, with 63 pre-vaginal and 4 post-vaginal annuli. Hooks removed from one side, BC 530, 540; AD 860, 890.

Discussion

The only pentastomid described from *P. textilis* is a female which was tentatively identified as *W. porphyriacus* purely on the basis of similarities in annulus counts: hooks were not measured (Riley & Self 1981b). The present fully mature specimen has far fewer pre-vaginal annuli (63 *contra* 75) than the type series of *W. porphyriacus*. Hook dimensions are very much smaller than those of *W. porphyriacus* and similar to *W. superbus* from a

copperhead, *Austrelaps superbus* (Günther), and to an unnamed species from a mainland tiger snake, *Notechis scutatus* (Peters) (Riley & Self 1981b). Two other characters, the number of annuli and the attenuated caudal extremity, also place it close to these species. However, the type series of *W. superbus* was derived from copperheads taken in Tasmania and nearby islands (Riley & Self 1981b), as was a more recently described infection (Riley *et al.* 1985). To date, *W. superbus* is recognised only as an island species, although copperheads are known on the mainland where their range overlaps that of *P. textilis*. Different dietary preferences have been reported in these snakes (Cogger 1983) however, the food habits of different populations of a snake species over its geographic range are not well known. Recent evidence suggests strongly that dietary preference is different in regions where food resources are skewed or limiting (Schwaner 1985). Until more specimens become available the status of the *Waddycephalus* from *Pseudonaja textilis* remains uncertain.

Waddycephalus sp. b

Material Examined

From lung of *Notechis ater niger* Kinghorn, Reevesby L., South Australia, in SAM No. N1985151.

Description

Female ($n = 2$). Both specimens in very poor condition, length about 36–38, no detail of annulation could be discerned. Hooks from one specimen, BC 400, 410; AD 705, 690.

Discussion

The hooks are much smaller than those of all recognised species of *Waddycephalus* except *W. scutata*, also taken from a tiger snake, on St Francis Island, South Australia. Riley & Self (1981b) recorded the host of the type as *Notechis scutata* (= *scutatus*), based on the collector's label in the vial. Cogger (1983) recognised *N. scutatus* as a purely mainland species being replaced by *N. ater* on islands off the coast of South Australia. However, recent studies of morphological variation in tiger snakes on Kangaroo Island have revealed banded, unbanded, red-bellied and melanistic forms believed to belong to the same species complex (Schwaner 1984). Thus *W. scutata* is currently recognised as a parasite only of island populations of the *N. scutatus/ater* complex, its principal distinguishing characteristic being its particularly small hooks. Hook dimensions in the present specimens form a cluster distinct from *W. scutata* (compare with Fig. 6 in Riley & Self 1981b and below) and suggestive of a new species of *Waddycephalus*.

Waddycephalus sp. c

Material Examined

From lung of *Notechis scutatus* (Peters), Grampians, Victoria, in SAM No. N1980171.

Description

Female ($n = 7$). Length 32–43 ($\bar{x} = 38$), with 60–63 pre-vaginal ($\bar{x} = 61.5$) and 2–5 ($\bar{x} = 3.2$) post-vaginal annuli. Hooks taken from one side of 32 mm and 40 mm females, BC 495, 535; AD 885, 910 respectively.

Male ($n = 4$). Length 14–20 ($\bar{x} = 16$), 62–68 annuli ($\bar{x} = 64$).

Discussion

In their review of the genus *Waddycephalus* Riley & Self (1981b) separated the species from tiger snakes (*Notechis* spp.) into two groups distinguished principally by marked differences in hook size: small hooks are characteristic of *W. scutata* from island populations of the *Notechis scutatus/ater* complex whereas larger hooks are found in specimens from mainland tiger snakes (see Fig. 6 in Riley & Self 1981b). They concluded that geographical isolation was responsible for the observed differences and that two hosts may be involved. The present findings substantiate these differences and combine to suggest indeed that there may be two species of *Waddycephalus* infecting tiger snakes. More sophisticated diagnostic techniques, preferably utilizing live material, are required to confirm this postulate.

Waddycephalus superbus Riley & Self

Material Examined

From lung of *Austrelaps superbus* (Günther), (a) Launceston, (b) Longford, Tasmania, in SAM Nos. (a) N1980175, (b) N1980205.

Description

Female (a) ($n = 3$). Length 37–41, with 59–63 pre-vaginal and 3–4 post-vaginal annuli. Hooks from one side of 40 mm specimen, BC 530, 580; AD 900, 970.

Female (b) ($n = 2$). Most of abdomens missing, annuli uncountable; both apparently mature. Hooks dissected from one side of both females, BC 525, 525; AD 840, 840 respectively.

Male (b) ($n = 1$). Length 15, possibly 62 annuli.

Discussion

These specimens are very similar to the type series of *W. superbus* (from the same host species also taken in Tasmania) except that one specimen from Launceston has two more abdominal annuli and the hooks are slightly larger than those described by

Riley & Self (1981b) and Riley *et al.* (1985). Nevertheless, all of the hook dimensions measured to date combine to form a discrete cluster group and this species at least, is now well characterized. All specimens recovered thus far come from Tasmania, endorsing the suggestion that *Waddycephalus teretiusculus* Baird, 1862, the type species of the taxon and also occurring in the copperhead, is probably a mainland species (Riley & Self 1981b, Riley *et al.* 1985). Lungs of specimens of *A. superbus* held in the Australian National Wildlife Collection were examined for *W. teretiusculus* from the following mainland localities (numbers of specimens in parentheses) but pentastomids were not recovered: Mt Gingera, ACT (1); Ginini Flats, ACT (1); Captain's Flat, NSW (3); Pepper Creek on Big Badja Mountain via Numeralla, NSW (1); Kosciusko National Park near Kiandra entrance (1) and near Peak River, NSW (1); Tumbarumba, NSW (1); Portland, Vic. (2); Flinders I. (1).

Waddycephalus sp. d

Material Examined

From lung of *Drysdalia coronoides* (Günther), Fenelon I., South Australia, in SAM No. N1985152.

Description

Female (n = 1). Immature, slide-mounted. Length 10, with 56 pre-vaginal and 5 post-vaginal annuli. Hook measurements BC 280, 300; AD 430, 420.

Male (n = 1). Immature; slide-mounted. Length 9, with 64 annuli.

Discussion

The host snake was originally recorded as *Denisonia coronoides* but species of *Drysdalia* were formerly included in the genus *Denisonia*. The immature state of the present specimens precludes specific identification.

Waddycephalus punctulatus Riley & Self

Material Examined

From lung of *Dendrelaphis punctulata* (Gray), Northern Territory, in SAM No. N1985153.

Description

Female (n = 1). Length 33, with 52 pre-vaginal and 11 post-vaginal annuli.

Male (n = 1). Length 14, possibly 61 annuli.

Discussion

There is no confusion concerning the status of these specimens from the common tree snake; their size and annulus number agree well with the original description of *W. punctulatus* (Riley & Self 1981b).

Waddycephalus sp. e

Material Examined

From lung of *Morelia spilota* (Lacépède), St Francis I., South Australia, in SAM No. N1985154.

Description

Female (n = 1). Immature, length 9.5, with 52 pre-vaginal and 4 or 5 post-vaginal annuli.

Discussion

The anterior part of the cephalothorax, including the pair of inner hooks and the mouth are missing. The outer hooks lack the projecting spine characteristic of *Parasambonia* spp. (Riley & Self 1982). The position of the vagina places the specimen in the family Sambonidae and the annulus count indicates that it is a species of *Waddycephalus* but, it has far fewer annuli than the immature female described previously from the same host species and tentatively identified as *W. porphyriacus* (Riley & Self 1981b).

Nymphal *Waddycephalus* spp.

Material Examined

(i) from *Parantechinus apicalis* (Gray), locality unknown, in SAM No. N1980210.

(ii) Encysted in a skink, *Hemiergis decresiensis* (Cuvier), South Australia, in SAM No. 1985155.

(iii) Encysted in abdomen of *Dasykaluta rosamondae* Ride (a) Woodstock Station, (b) Abydos Station, near Marble Bar, Western Australia, in SAM Nos. (a) N1985156, (b) N1980182.

(iv) One nymph, from below post-orbital skin of a frog, *Ranidella remota* Tyler & Parker, Papua New Guinea, in SAM No. N1985157.

(v) 14 nymphs encysted in intestinal connective tissue of *Cryptophis nigrescens* (Günther), Mogo S.F., New South Wales, in SAM No. N1986190.

(vi) 3 nymphs encysted in gecko, *Heteronotia binoei* (Gray), Girraween National Park, Wyberba, Queensland, in QM No. W12194.

Description

(i) Three nymphs dissected from cysts and slide-mounted. Length about 6, 1 specimen (sex unknown) with 74 annuli, 1 male with 70 annuli. All hooks double, overlain by accessory spine (Fig. 2) the base of which arises from a point between fulcrum and hook. Spine an integral part of hook and attached to fulcrum only by thin, flexible sheet of cuticle. Overall hook length (measurement as illustrated in Fig. 2) 300–340.

(ii) Three nymphs dissected from cysts and slide mounted. Length about 4–5, with 62–63 annuli, sex indeterminable. Hooks double, overall length 210–250 (Fig. 1C).

(iii) All dissected from cysts and slide-mounted. Length about 6, with 56–62 annuli (\bar{x} = 60). Hooks double, overall length 250–280.

(iiib) Six small cysts opened and nymphs slide-mounted, large composite cyst containing many larvae left intact. Length 4–5, with 56–59 annuli (3 counted). Hooks double, overall length 230–260.

(iv) Male nymph, length approximately 4, with 56 annuli. Hooks double, not dissected and measured.

(v) Three nymphs slide-mounted. Length about 5, with 56–58 annuli (\bar{x} = 57). Hooks double, overall length 170–180.

(vi) Length about 5, with 56–61 annuli (\bar{x} = 58). Hooks double, overall length 195–215.

Discussion

Riley *et al.* (1985) ascribed a double-hooked male nymph from the northern quoll, *Satanellus hallucatus* (Gould), to the genus *Waddycephalus* exclusively on the number of annuli, which vary from 55–78 in adult males of the genus (Riley & Self 1981b). This is considerably more than occurs in the two other genera which may have double-hooked larvae, *Elenia* and *Parasamhonia* (Heymons 1939, Riley & Self 1982, Riley *et al.* 1985). All of the present specimens are placed in the genus *Waddycephalus* for the same reason, although specific identification is not possible.

The specimens from *D. rosamondae* probably belong to the same species, those from Abydos Station being at a slightly earlier stage of development.

The nymph from *R. remota* may be *W. punctulatus*. This species was first described from the common tree snake *Dendrelaphis punctulata* (Gray) in Australia (Riley & Self 1981b) but this host also occurs in New Guinea (Cogger 1983). The prey of tree snakes consist of frogs and birds, although reptiles and small mammals are occasionally eaten (Cogger 1983). Clearly frogs are probable intermediate hosts of *W. punctulatus*.

Either *Waddycephalus* or *Elenia* sp

Material Examined

One nymph, from submandibular lymphatic sac of a frog, *Palmatorappia salomonis* (Sternfeld) Solomon Islands, in SAM No. N1985158.

Description

Male. Length 5, with 48 annuli. Hooks double, overall length 220–230.

Discussion

The generic status of this nymph is uncertain. *Waddycephalus komodoensis* and *W. radiata* are known from Indonesia (Riley & Self 1981b) and

Elenia vitiensis is known from the Islands of Fiji (Heymons 1932). The low annulus count of the specimen may just preclude it being a species of *Waddycephalus*, the lowest annulus number known in mature males is 52, occurring in *W. komodoensis* (Riley & Self 1981b).

Armillifer sp. from snakes and rodents

Armillifer australis Riley & Self

Material Examined

(i) From viscera (the specimens probably inhabited the membranous lung which is often mistaken for the abdominal cavity) of a python (species unknown), South Australia, in SAM No. N1980207.

(ii) From lung of *Morelia amethystina* (Schneider), Melbourne Zoo, in SAM No. N1980206.

(iii) From lung of *Morelia spilota* (Lacépède), Queensland, in SAM No. N1980208.

(iv) From lung of *Morelia spilota* (Lacépède), Melbourne Zoo, in SAM No. N1980172.

(v) Encysted nymph from body cavity of *Rattus leucopus cooktownensis* Tate, Queensland, in SAM No. N1980209.

Description

(i) *Female* (n = 2). Length 63 and 67, both with 31 annuli and 2 incomplete annuli on terminal segment. Hooks removed from one side of one female, AC 410; AD 625 (Fig. 1D). *Male* (n = 2). Length 21 and 22, with 40 annuli; first 12 annuli with pair of projections pointing backward from posterior lateral angles.

(ii) *Female* (n = 15). Length 34–53 (one punctured female not included) (\bar{x} = 42.5), with 29–32 annuli (\bar{x} = 30.6) and 2 (or in two cases, 3) incomplete annuli on terminal segment. Hooks from a 49 mm specimen, AC 440; AD 635.

(iii) *Female* — mature (n = 1). Length 47, with 32 annuli (plus two incomplete segments terminally). *Female* — immature (n = 4). Length 16–27 (\bar{x} = 19), with 29–32 annuli (plus 2 incomplete). *Male* (n = 3). Length 16–17, with 36–37 annuli, anterior 11–12 bearing backward-pointing projections.

(iv) *Female* (n = 1). Length 46, with 32 annuli (plus 3 incomplete).

(v) *Female*(?) (n = 1). Length 6, with 31 or 32 annuli. Hooks simple but could not be measured.

Discussion

Adult specimens from the four snakes are unmistakably *A. australis* and all characters accord perfectly with those of the type series (Riley & Self 1981a). *Morelia spilota* is a new host record.

Hooks of the nymph from *R. leucopus* are simple (i.e. without an accessory spine) and the annulus count is within the range (29–35) of mature female *A. australis* (Riley & Self 1981a). The present specimen almost certainly belongs to this taxon, as other species of *Armillifer* described from Australian hosts have more annuli (Riley & Self 1981a, Riley *et al.* 1985).

DISCUSSION

In our earlier review of pentastomid parasites in Australian reptiles and mammals (Riley *et al.* 1985) we noted that the state of our knowledge of taxonomy is embryonic, and this is particularly true of the genus *Waddycephalus*. Our original finding of a double-hooked larva, which we attributed to the genus *Waddycephalus* rather than *Elenia* solely on the basis of the number of abdominal annuli, was the first implication of mammals as intermediate hosts in this genus.

This single male larva, from the mesentery of *Satanellus hallucatus* was cleared and mounted (Fig. 1B) and we observed that the sharp spinous extension overlying the hook appeared to be an integral part of it and separate from the fulcrum. This is unlike the situation in the related genus *Sambonia* where the accessory spine is clearly an extension of the fulcrum (Fain & Mortelmans 1960). The relative abundance of nymphal *Waddycephalus* material in the present study has permitted more detailed observations of hook morphology and these have confirmed our earlier interpretation. The spine is a functional part of the hook. It possesses an apodeme, onto which muscles attach and extend from it down into the fulcrum (contrast Figs 1C and

D). The relative positions of the hook, its spinous extension and the fulcrum are presented diagrammatically (Fig. 2).

The seven species of *Waddycephalus* currently recognised in Australia infect boid, colubrid and elapid snakes (Riley & Self 1981b) which prey upon a variety of vertebrates (mostly frogs, lizards or mammals — see Cogger 1983) and the present report of *Waddycephalus* nymphs from these three classes of vertebrates is to be expected, particularly since vertebrate intermediate hosts are usual in porocephalid life-cycles (Nicoli & Nicoli 1966). Also, there is growing evidence from experimental infections (Esslinger 1962, Vargas 1970, Winch & Riley 1986), and from recoveries of nymphs in intermediate hosts (Sachs, Rack & Woodford 1973), that the definitive number of annuli is present in porocephalids by the infective stage. Our tentative diagnoses are based on the assumption that this occurs in the genus *Waddycephalus*. From the viewpoint of host dietary regimen, it is equally likely that the related genera *Parasambonia* and *Elenia* also utilize vertebrate intermediate hosts but in all cases, experimental evidence of these life-cycles is required.

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LOOKING FOR DITJI-MINGKA

BY L. A. HERCUS

Summary

Ditji-mingka was an important Aboriginal site in the north-east of South Australia. The present paper contains a Wangkangurru text describing what has happened to this site.

LOOKING FOR DITJI-MINGKA

L. A. HERCUS

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Ditji-mingka was an important Aboriginal site in the north-east of South Australia. The present paper contains a Wangkangurru text describing what has happened to this site.

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Ditji-mingka, 'Sun-Cave' (lit. 'Sun-Hole'), south-west of Etadunna on the Birdsville Track in north-eastern South Australia, was one of the most important places in Diyari mythology. Evidence of this comes from J. G. Reuther who worked for eighteen years (1888-1906) as a missionary amongst Diyari and neighbouring people at Killalpaninna on the lower Cooper. There was nobody who could rival the achievements of the Reverend Reuther in documenting the languages and traditions of the Lake Eyre Basin. Without his great work of fourteen volumes, recently translated by P. Scherer (Reuther 1981), much information would be totally lost. He gives the following account of the *Ditji-mingka* site in his list of place-names.

Ditji = 'sun'; *minka* = 'cave'.

'There is a cave at this spot, where the female sun *muramura* is said to have first risen. But since she made conditions too hot for her followers ('people') she wandered inside the earth towards the east and has been rising there ever since' (Reuther 1981; VII: 29).

There are two expanded accounts of the *Ditji-mingka* story given by J. G. Reuther (1981, VIII: 20 and X: 20). In the latter he describes how *Ditji*, the Sun, was one of the two wives of the Wild Onion Ancestor 'Jelkabalubaluna' (i.e. *Yalka parluparlunha*, 'a wild Onion peeled'); *Ditji* crawled into the earth at *Ditji-mingka*. He makes other references to the site; the most telling of these is in XI: 163 where he describes 'the enchantment of the sun', i.e. a form of magic for creating hot weather. This magic was carried out with the use of '*ditjipupara*' (earth from *Ditji-mingka*). Reuther adds: 'Everyone who is a devotee of the female *muramura*, *Ditji*, has some of it in his wurley' (1981, XI: 163).

There can thus be no question about the importance of the site. The Reverend Reuther — as is clear from Wangkangurru evidence — usually gives a 'cleaned up' version of mythological traditions. We cannot be certain whether he himself censored the myths, or whether Aboriginal people, who respected him, were reluctant to tell him things they knew would offend him. His accounts are dull

and humourless: all the spice has been taken out. There was certainly more to the story of *Ditji-mingka* than he implies, and there were associated rituals. The police trooper Samuel Gason was the first to publish details of Diyari traditions. He was not a missionary, but after all, he lived in the Victorian era. He was clearly shocked by the Sun rituals and gives the following version:

Their traditions suppose that man and all other beings were created by the moon, at the bidding of the Mooramoorra. (This term simply means "Ancestor"). Finding the emu pleasant to the sight, and judging it to be eatable (but unable, owing to its swiftness to catch it during the cold that then prevailed), the Mooramoorra was appealed to to cast some heat on the earth so as to enable them to run down the desired bird. The Mooramoorra, complying with their request, bade them perform certain ceremonies (yet observed, but too obscene to be described), and then created the sun' (Gason 1879: 260).

Other versions of the sun-legend, all involving *Ditji-mingka*, the cave of the sun, are given by Siebert (1910: 44-45) and by Howitt (1904: 427). Aiston gives yet another, different account of the Sun History, in which the Sun Ancestor is regarded as male. The cave however still figures prominently:

'The moora, however, escaped, but so annoyed was he, that he sank and sank, until at last, at the place now called in memory of the event Ditchaminka, he plunged into the ground. To this day is shown the hole in the stony plain where the sun disappeared' (Horn & Aiston 1924:131).

Diyari rituals gradually fell into oblivion because of the disintegration of the group and because of pressure against 'paganism' from the missionaries. Nevertheless the myth and the knowledge of the *Ditji-mingka* site did not immediately fade from the minds of Diyari people. H. K. Fry (1937: 189-194) published a brief Diyari text, with English translation, of a myth called '*Ditji-mingka Mura and Pinja, Sun Cave Mura Revenge*'. Apart from the name in the title, this text does not actually mention that the female Sun Ancestor is involved. There can however be no doubt that it is an

uncensored version of the same myth as in Reuther (1981, X: 20): the Old Woman in Fry's story, like Reuther's 'Ditji', is one of the two wives of the Wild Onion Man 'Jelkapalupaluna'. This text was given to Fry and Vogelsang by an old Diyari man 'Sam' Dintibana Kinjmilina, who owned the myth at that time, in the mid-1930s. Sam also told Fry that he had a 'sun-bag' filled with light blue earth from *Ditji-mingka* which he claimed could be used to 'sing the sun and make it very hot' (Fry 1937: 193).

It is of the nature of cult-heroes that they may be larger and more extreme than the ordinary things of life. The female Sun Ancestor and her older sister in Sam Dintibana's story certainly were: they are depicted as grotesque and fearsome old women who got their husband 'Jelkapalupaluna' killed, cut him into small pieces and mutilated the body, and then mutilated themselves. The Diyari text only gives us an outline, but we can begin to imagine why the full story does not appear in Reuther's work and why Gason was shocked. The important matter is that despite the missionary disapproval of earlier years, the myth was still alive in the 1930s in Sam Dintibana's mind. Even after Sam's death the knowledge that *Ditji-mingka* was a special place, a ritual centre, lingered on and the older people with Diyari associations had a deep affection for it. This became clear to me over the years that I was travelling on the Birdsville track for language work at both Marree and Birdsville.

Ditji-mingka was often mentioned by Mick McLean *Irinjili*, by Jimmy Russell *Wanga-mirri* ('Many mornings'), and also by Ben Murray *Palku-nguyu* ('One mass of clouds'). Whenever we headed north on the Birdsville track we would pass Blaze's Well, a well which is now totally silted up. It was in a small depression which they called *Thidna-kurduni* ['Making a (deep) Footprint'] because it was there that *Ditji*, the Sun Ancestor, stepped into muddy ground while looking for wild onions. As we continued north towards Cannuwaukaninna Bore those older men would point nostalgically towards the west, saying: 'Over there is *Ditji-mingka*'. Mick and Jimmy were Wangkangurru, Ben's mother was Arabana, but they had all been associated with Diyari people (Hercus 1980, 1986; Austin 1981). They had learnt from them to admire the cave of the sun and were anxious to see it again. They often described it: it was in one of the more inhospitable areas on Etadunna station, in rough country. It was high up on the western slope of the ridge that faces the bed of the *Ditji-mingka* creek as it nears Lake Palankarinna. There was a soakage in the creek nearby and the old people used to camp there for their ceremonies (see Fig. 1).

The walls and the ceiling of the cave were of glistening gypsum which reflected the last rays of the setting sun: it was the home of the sun. There were rock-carvings inside, circles which symbolised the sun; Jimmy Russell had seen them. The two

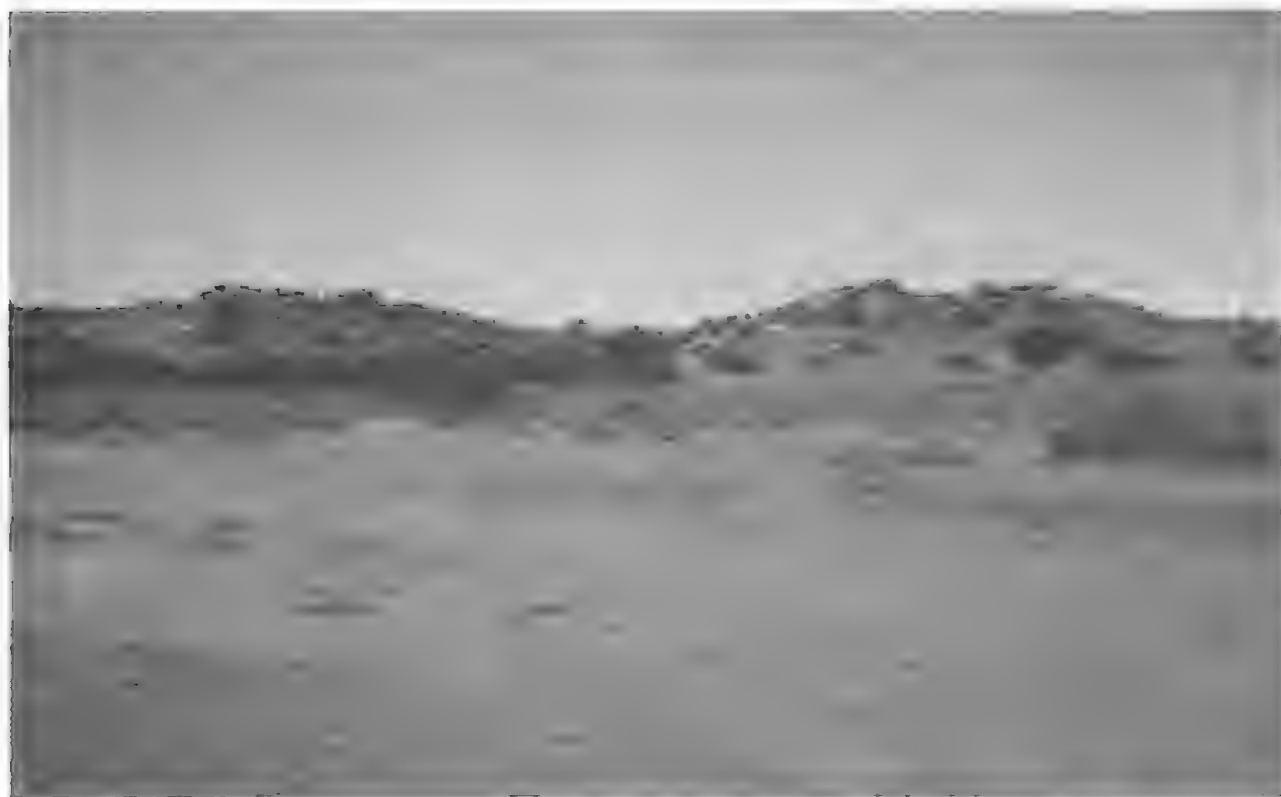


FIGURE 1. The edge of the bed of the *Ditji-mingka* Creek, where the soakage used to be. (Photo B. Jeffery.)

cave-openings were slightly upward; this meant that occasionally animals, particularly feral goats, fell in and died, not being able to get out again. It was a haven for snakes and this irritated the owners of nearby Etadunna station. Mick McLean and Jimmy Russell spoke of the cave so often that I wrote letters to have it protected; *Ditji-mingka* was truly a site of significance. Moreover it was only a few miles from Lake Palankarinna which was a declared geological reserve because of important fossil finds (Rich, van Tets & Knight 1985: 46 ff).

We were determined to see *Ditji-mingka* and tried a number of times in the early 1970s. Mick McLean was then well over eighty years old, he could not scramble up over the ridge, and on our own we

failed to find it despite his instructions. Next time in August 1974, Jimmy Russell came to help, he was only in his seventies and his sense of direction was uncanny, like Mick's. He was deeply ashamed, because he too could not find it. Later of course it became clear why! Finally in June 1976 we had quite a group of people, which included Jimmy Russell and Ben Murray, as well as members of the South Australian Government's Aboriginal Heritage Unit, along with linguists Tamsin Donaldson and Peter Austin who was then writing his grammar of Diyari (Austin 1981). We again went looking for *Ditji-mingka* (see Fig. 2). Later in camp Jimmy Russell spoke in Wangkangurru about what happened:¹

Text					
<i>l. thika-rna</i> Come-IMP	<i>arniri</i> we	<i>wadna-ya-rna</i> run -SP-IMP	<i>Itatinha</i> Etadunna	<i>yadla-ku</i> close-DAT	
<i>kari-rnda</i> see-PRES	<i>uta</i> now	<i>arniri</i> we	<i>yani-ngura</i> say-CONT	<i>mudlu-nga-thu</i> sandhill-LOC-EMPH	<i>arniri</i> we
<i>marrili</i> this side	<i>tharni-thika-lhuku</i> eat-return-PURP		<i>Ditji-mingka-ruku</i> Ditji-mingka-ALL	<i>mingka</i> cave	
<i>nhanhi-lhiku.</i> see -PURP.					



FIGURE 2. Ben Murray (left) and Jimmy Russell (right) setting out to look for *Ditji-mingka*. (Photo B. Jeffery.)

2. *wantali* *yurrakati-nga* *thika-lhuku* *arniri* *yuka-lhuku.*
 Separately west side-LOC come-HIST we go -HIST.

intja Ditji-mingka?
 Where *Ditji-mingka?*

3. *arniri* *yuka-ka* *partjarna* *wadlhu* *yurrakati-nga*
 We go -PAST all place west side -LOC

thika-lhuku *arniri,* *wadlhu* *pidla* *Thita-pulumanha.*
 return-HIST we, place name *Thita-pulumanha.*

4. *uta* *arniri* *partjarna* *karla-nga* *pathara* *midla-nga,*
 Now we all creek-LOC box tree nose-LOC,

thidna-ra -ki *yuka-rna* *mingka-thu* *wapa-rna* *thika-rna*
 foot-CAUS-EMPH go-IMP cave-EMPH seek-IMP come-IMP

thadna-rna, *wadni-rnda* *watungunta* *nguthi* *thika-lhuku.*
 leave-IMP, follow-PRES rest reverse come-HIST.

5. *nhararda* *waru* *katha-liparna,* *ipali* *katha-rna,*
 Here long ago walk-ANC, before walk-IMP,

malka-thu *mingka* *nhanhi,* *Ditji-mingka.*
 not-EMP cave see, *Ditji-mingka.*

kutha *irtjirtja* *thuntiripa-rna* *kutha* *kathiwiRi-ri*
 Water soakage cover over-IMP water big -ERG

tjiRi-ri.
 flood-ERG.

padni-li *punga* *nhanhi-ra,* *thanpi-liparna* *thiRi-ri*
 Not-ADV humpy see-PUNC, knock down-ANC flood-ERG

wanpa-rna,
 carry -IMP.

6. *kayi kadhna* *awukinta* *kadhna* *arniri* *wadna-yi-rnda.*
 Here rock this-ALL rock we run-TR-PRES.

yadla *witji-yangu,* *ayi!* *tjarlpa* *tharka-tharka-rnda*
 close become-PLUP, hey! tree stand-stand-PRES

nhararda *yadla...*
 here close..

7. *thanpi-thanpi-la-rda* *Ditji-mingka!*
 Destroy-destroy-ALT-PRES *Ditji-mingka!*

8. *L. What was it like before?*

J. ngurka *arla,* *parluru.* *antha* *iparli* *katha-nangka-rda*
 Good true, smooth. I before travel-CONT S-PRES

marna *parkulu* *nhanhi-ka* *ngurku-nhaku!* *kanhangarda*
 mouth two see-PAST good-EMPH! There

mingka *tharka-tharka-rnda* *mingka-rda.*
 cave stand-stand-PRES gape-PRES.

9. *antha nguyu* *katha-liparna* *nhantu-ra,* *marna-nga*
 I alone travel-ANC horse-CAUS, mouth-LOC

tharka-rnda. *mintji-mintji-rnda,* *muyu* *katinari* *yantakara*
 stand-PRES. Shine-shine-PRES, sun beyond west

muyu *mintji-ya-ra.*
 sun shine-TR-PUNC.

10. *malika* *antha* *wintaku-ra,* *antha* *nguyu-nguyu.*
 Not I go in-PRES, I alone-alone.

kutju-ru *pirda-lira* *nguyu-nguyu* *mingka-nga.*
 kurdaitcha-ERG kill-LEST alone-alone cave-LOC.

11. *antha* *thadla-ra* *waya-rna,* *thadla* *nhinka-rna-li.*
 I fear-CAUS want-IMP, frightened squint-IMP-EMPH.

mintji-mintji *yalkiri-ri.* *muy* *round one.*
 shine-shine kopi-INST. Sun.

12. *thanpi-thanpi-rda,* *partjarna* *thanpi-la-rda*
 Knock down-PRES, all destroy-ALT-PRES

parluru-ku
 level-DAT.

Translation

1. We came back (from looking at the lower Cooper) and drove in close to Etadunna. We had a look around and then started saying 'we'll have our lunch this side of the sandhill and then go to *Ditji-mingka* to have a look at the cave.'

2. (We split up) and walked separately coming and going over the west side of the sandhill. Where is *Ditji-mingka*?

3. We went all over the country on the west side and back again, that area is called *Thita-pulumanha*.

4. Then we all walked around in the creek bed, where the box-trees run out to a point. We were going about on foot, looking for the cave, we went and turned back again, we left, we followed the others but they came back as if they had got to a dead end.

5. I used to travel around here long ago, but I can't see that cave, *Ditji-mingka*. The soakage had been washed

out by big rains, by flood-waters. I couldn't see the humpies (that had been there), they must have been knocked down and carried away by the floods a long time ago.

6. 'Ah, here is that rock!!' (I said). So we all ran straight over towards the rock. We got near: 'Ah, that tree is standing over there, we're really close!'

7. They have blown up *Ditji-mingka*!

8. L. What was it like before?

J. It was lovely, all smooth.

When I was travelling about a long time ago I saw the two openings of the cave. It was beautiful. I stood there for a while just looking at the cave.

9. I was travelling about alone on my horse, and I stood in the mouth of the cave. It was gleaming and glistening, the sun was shining in from the west.

10. I didn't go in, I was on my own. (I thought) a kurdaitcha [revenge killer] might come and kill me if I was all alone in that cave.

11. I was terrified. I peered in, very frightened. It was glistening with kopi. There was (engravings of) the sun there, round ones.

12. It has been destroyed, completely blown apart (with dynamite), razed to the ground! (see Fig. 3).

CONCLUSION

In 1879 Gason, as was typical of the period, had a very restricted view of Aboriginal religion, when, as quoted above he states with obvious lack of enthusiasm: 'Their traditions suppose that man and all other beings were created by the moon, at the bidding of the Mooramoorra' (Gason *op. cit.*). We tend to take an equally simplistic view nowadays when we identify sites on a one to one basis with traditions: we are often told for instance in popular reporting that the destruction of a particular tree might result in the Aboriginal myth associated with it being forgotten. There is more to traditional mythology than that. This has often been said, and it was expressed with special clarity in 1965 by W. E. H. Stanner in his well-known article 'Religion, Totemism and Symbolism', where he shows the subtlety and intricacy of Aboriginal religious thought. Speaking of the totemic symbol-function he states that it has: 'four elements (i) living men (totemists) serving as interpreters of (ii) signs (totems and totem-places), by using (iii) vehicles that form and express affective conceptions of (iv) sign-objects, which are the significance of the Dream Time marvels' (Stanner 1965: 228).

If we look at these elements with regard to the Diyari Sun Myth we can see that the first to be

impaired was (iii), in that the ritual, the dances, the songs and the detail of the stories fell into oblivion. Therefore (iv), the deeper symbolism, the marvel of the Dream Time Sun Myth has disappeared for ever. All we are left with is the bare outline of the story. Until recently we still had (ii) the totem-place. The situation was no worse than for much of the mythology of eastern Australia, where we usually just have minimal stories and the totem place. Although we lacked the vehicle of interpretation provided by the chants and dances, we might still have had a glimpse of one aspect of the marvels of the Dream Time through the engraving and through the appearance of the cave, but this has now gone through the destruction caused by European activity. This leaves us only with (i), the living men. For many years, since the death of 'Sam' Dintibana, there has not been anyone who 'belonged' to the Sun Myth and identified with it. There are only two people living to whom the mythology of *Ditji-mingka* and the surrounding areas still means something: they are Jimmy Russell who has suffered a major stroke and Ben Murray who is now in his nineties. Therefore it is sadly true that soon there will be no one who can stop on the Birdsville Track at the right spot south of Etadunna, look across to the west, and visualise that not far away is Lake Palankarinna- an expanse of white fading away into the distance into an endless plain (see Fig. 4). No one will remember the humour of the story of the wicked Old Man *Markanjangkurla* who chased the Seven Sisters across the lake and across the plain beyond and recall what he did there,



FIGURE 3. The heap of rubble that used to be *Ditjiminka*. (Photo B. Jeffery.)



FIGURE 4. Looking towards Lake Palankarinna from near *Ditji-mingka*. (Photo B. Jeffery.)

(Lake Palankarinna, which Europeans know mainly as a fossil reserve, is really *parla-ng-kari-nha*, a crude name, since *parla* means 'semen' and *kari* means 'to chase'). Very soon there will be no one that can even visualise the cave south of Lake Palankarinna and point and say: 'Over there *was* *Ditji-mingka*'. We have lost the Sun Myth with all its symbolism.

ENDNOTES

1. The text transcribed in this paper was recorded in June 1976 as Hercus field-tape 739, a copy of which has been deposited with the Australian Institute of Aboriginal Studies, Canberra. For ease of reference the text has been split into numbered sections. The divisions are on the whole in accordance with intervals in speech. In this paper a practical orthography has been used for Wangkangurru: Plosive consonants other than the retroflex plosive have been written as unvoiced (*k*, *p*, *th*, *t*), but prestopped consonants have been written with voiced plosives as this corresponds most closely to the pronunciation, hence *bm*, *dn*, *dnh*, *dnj*, *dl*, *dlh*.

Retroflexes have been written as *r* + consonant, i.e.

rl is retroflex *l*
rn is retroflex *n*
rd is retroflex *t*

Interdentals have been written as consonant + *h*, hence *nh*, *th*, *lh*.

Palatals have been written as consonant + *j*, hence *tj*, *nj*, *lj*. *ng* has been used for velar *n*.

The three r-sounds have been transcribed as follows:

r = the alveolar flap
rr = the trilled *r*
R = retroflex *r*.

The following abbreviations have been used for linguistic terms in the interlinear gloss:

ABL	Ablative case
ACC	accusative case
ACT	active stem-forming suffix
ADV	adverbial suffix
ALL	allative case
ALT	altruistic stem-forming suffix
ANC	ancient past
CAUS	causative case
CONT	continuous participle
CONT S	continuous stem-forming suffix
DIST	aspect showing distance
EMPH	emphatic clitic
ERG	ergative case
EXCL	exclusive pronoun
HAB	habitual aspect
HIST	historical past
IMP	imperfective
LOC	locative case
NAR	narrative past
PAST	past tense
PERF	perfect
PLUP	pluperfect
POS	possessive suffix
PRES	present tense
PUNC	punctiliar present
PURP	purposive
SP	speed form, indicating action undertaken before departing
TR	transitory aspect

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THE SCALED-SQUID LEPIDOTEUTHIS GRIMALDII JOUBIN FROM SOUTH AUSTRALIAN WATERS

BY W. ZEIDLER

Summary

The first substantiated record of *Lepidoteuthis grimaldii* from Australian waters (i.e. within the 200 nautical mile fishing zone) was by Lu & Phillips (1985) but they gave no details of specimens. The purpose of this paper is to provide more details of these specimens, in particular of one in the South Australian Museum (SAM) which was not seen by Lu & Phillips, and thus highlight this interesting record from Australian waters.

THE SCALED-SQUID *LEPIDOTEUTHIS GRIMALDII* JOUBIN FROM SOUTHERN AUSTRALIAN WATERS

The first substantiated record of *Lepidoteuthis grimaldii* from Australian waters (i.e. within the 200 nautical mile fishing zone) was by Lu & Phillips (1985) but they gave no details of specimens. The purpose of this paper is to provide more details of these specimens, in particular of one in the South Australian Museum (SAM) which was not seen by Lu & Phillips, and thus highlight this interesting record from Australian waters.

Lepidoteuthis grimaldii was first described by Joubin (1895) from two mantles from a sperm whale's stomach and from a fragment of a Risso's dolphin, both caught off the Azores. However, up until 1960 there had been only four records of this species and only two included the head (Clarke 1960) and a complete description was not available until 1962 (Clarke & Maul 1962). Since then the species has been recorded from most of the world's oceans, North and South Atlantic (Clarke 1966), Indian Ocean (Clarke 1980), Pacific Ocean between the New Hebrides and New Caledonia (Rancurel 1970), Pacific Ocean off Japan (Okutani *et al.* 1976), Tasman Sea (Clarke & MacLeod 1982) and Southern Ocean (Lu & Phillips 1985).

Complete specimens are still rare and apart from juveniles caught in nets (Clarke 1964 & 1980, Lu & Clarke 1975, Roper & Young 1975) and the record of Lu & Phillips (1985) all specimens have been obtained from the stomachs of predators, mainly the sperm whale, *Physeter catodon*, but also from Risso's dolphin, *Grampus griseus* (Joubin 1895); the lancet fish, *Alepisaurus ferox* (Rancurel 1970); the black-scabbard fish, *Aphanopus curbo* (Clarke & Maul 1962) and the tuna, *Gerres obesus* (Clarke & Maul 1962).

The first published evidence that *L. grimaldii* might occur in Australian waters was provided by Clarke (1980) who recorded the buccal mass of two specimens from the stomachs of sperm whales caught by whaling ships operating out of Albany, Western Australia. Clarke & MacLeod (1982) also recorded the remains of specimens from the stomachs of sperm whales killed in the Tasman Sea between 33°S, 172°E and 40°S, 155°E but this is at least 550 km south-east of Cape Huve, eastern Australia. The Australian specimens referred to by Lu & Phillips (1985) and the one in SAM are noteworthy in that they are the first records of adults from other than predators' stomachs and indicate that the species occurs relatively close inshore along the south coast well within reach of commercial trawlers.

Details of specimens are as follows:

1. Male, 122 mm dorsal mantle length, 97 km east

off Broken Bay, New South Wales (33° 28'S, 152° 33'E), depth 0-1000 m, Engel mid-water trawl, FRV 'Kapala', J. Paxton, 14 December 1977 (Australian Museum, Sydney AM, C111782).

2. Sex undetermined (viscera missing), 755 mm mantle length, approx. 50 km south-west off Beachport, South Australia, trawled in 550 m by 'Margaret Phillipa', 6-10 September 1982 (Museum of Victoria MV, F53159).

3. Sex undetermined (viscera decayed), 790 mm dorsal mantle length, approx. 40 km south-west off Beachport, South Australia, trawled in 220 m, obtained fresh from fish processor in Portland, Victoria by W. Zeidler, 22 October 1981 (SAM, D17589).

Specimen 1, a juvenile, is in relatively good condition and only the tips of the arms are missing. Generally it agrees with the description of young stages given by Clarke (1964) and some body measurements are given in Table 1.

TABLE 1. *Lepidoteuthis grimaldii* body measurements.

Character	Measurement (mm)	
	Specimen 1	Specimen 3
Mantle length (dorsal)	122	790
Mantle length (ventral)	115	740
Mantle width (max)	26	210
Fin length	60	410
Fin width (max)	50	240
Gladius length	-	790
Gladius width (max)	-	63
Rachis length	-	480
Rachis width (max)	-	28
Max. width of scales	1.5	10

Specimen 2 is too damaged for accurate measurements.

Specimen 3 (Fig. 1) when collected was in good condition with only the tips of the arms missing. However, it was inadvertently left out of the freezer and deteriorated considerably before being measured and preserved. The head is too damaged for accurate measurement, other body measurements (Table 1) are according to Roper & Voss (1983) and beak dimensions (Table 2) are according to Wolff (1984). Some measurements are inaccurate due to the damaged nature of the specimen e.g. the fins are contracted, dorsal mantle length probably is longer as the tip of the tail is damaged and about 70 mm is missing and the mantle is probably not as wide when all internal

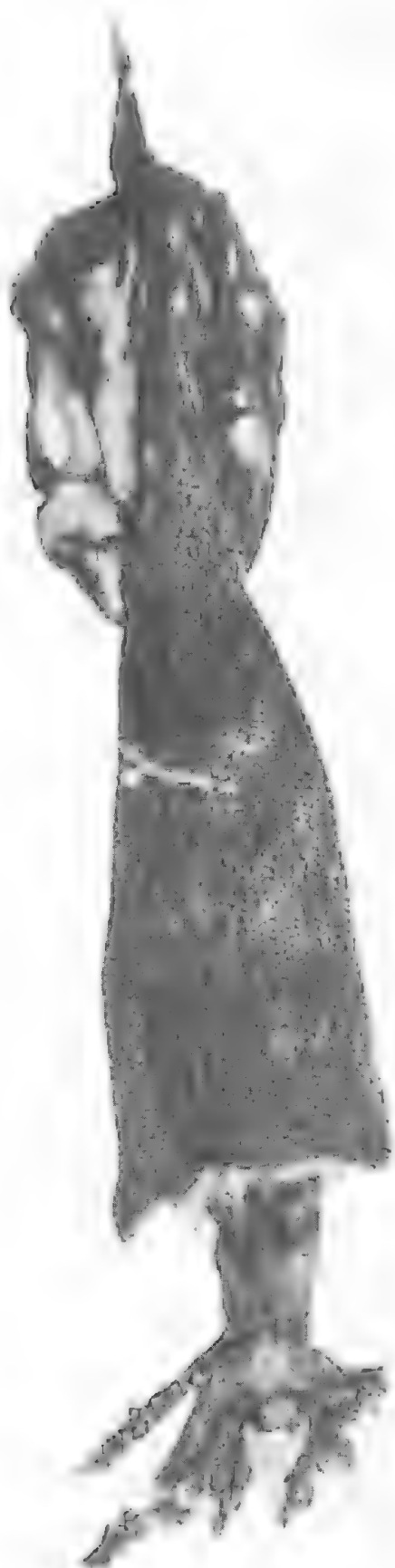


FIGURE 1. Ventral view of *Lepidoteuthis grimaldii*, SAM, D. 17589.

organs are intact. The beaks (Fig. 2a-c), radula (Fig. 2d) and gladius have been adequately described for this species by Clarke & Maul (1962) and the SAM specimen does not differ from that description.

TABLE 2. *Lepidoteuthis grimaldii* (SAM, D17589) beak dimensions.

Character	Measurement (mm)
<i>Upper</i>	
Hood length	39.5
Rostral length	17.6
Wing width	9.5
Rostral tip to inner margin of wing	26.0
Wing to crest length	43.2
Crest length	59.6
Jaw angle width	10.0
<i>Lower</i>	
Rostral tip to inner posterior corner of lateral wall	41.2
Rostral length	17.3
Rostral tip to inner margin of wing	35.2
Wing length	18.3
Jaw angle width	9.3

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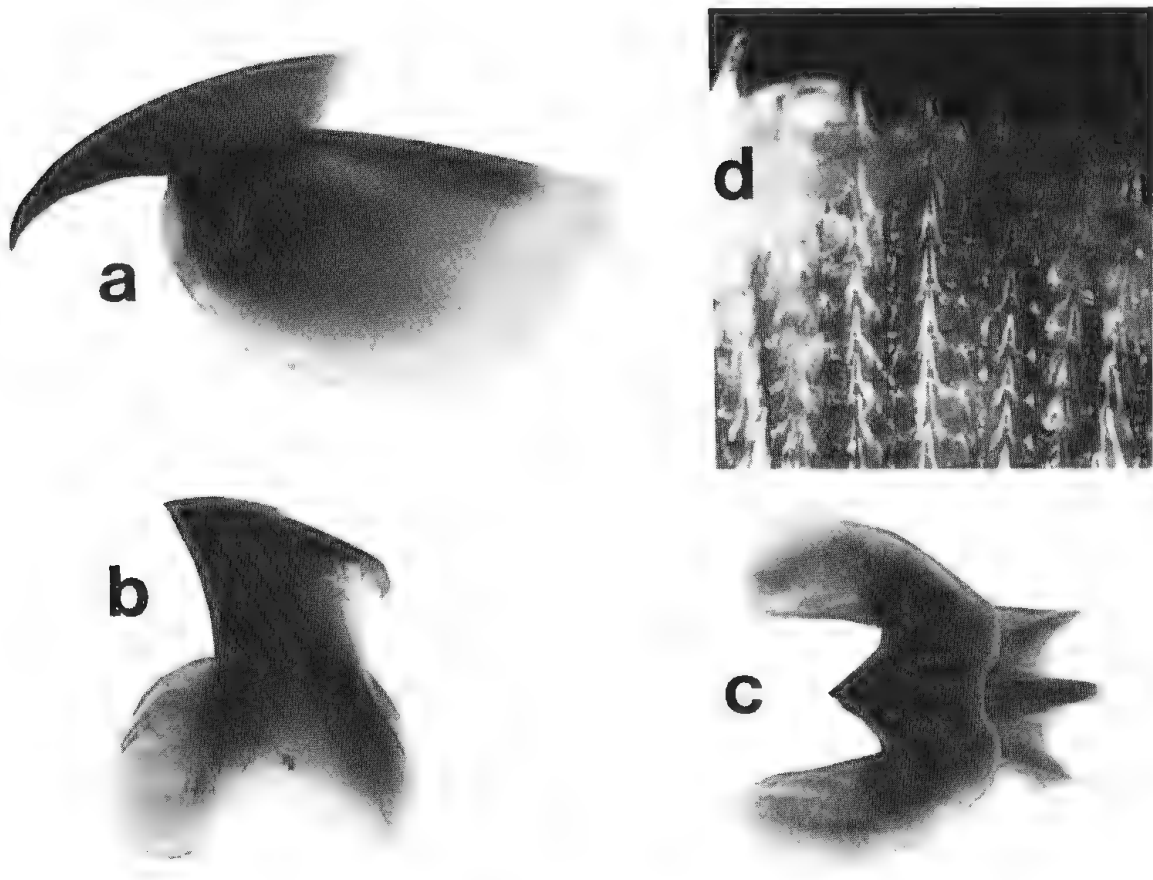


FIGURE 2. *Lepidoteuthis grimaldii* (SAM, D17589); a. Upper beak; b, c. Lower beak; d. Radula.

REVIEW : FROM HORIZONTAL TO PERPENDICULAR : TWO RECENT BOOKS ON CENTRAL AUSTRALIAN ABORIGINAL PAINTING

BY P. SUTTON

Summary

Albert Namatjira, the life and work of an Australian painter by Nadine Amadio, Anne Blackwell, Jonah Jones & Daniel Thomas. Macmillan, Melbourne, 1986. ix + 102 pp. illus. Cloth only. \$A29.95.

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REVIEW

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'The interaction between the European and Aboriginal artistic traditions can produce a renaissance potentially as significant for Australian life as that which was launched upon Europe by the spread of the "new knowledge" from Constantinople in the sixteenth century'. With these dramatic words Dr H.C. Coombs launches his introduction to the most recent book on the work of Albert Namatjira, compiled and edited by Nadine Amadio, arts editor of Sydney's *Sunday Telegraph*. Dr Coombs is certainly right to point out that Aboriginal graphic and sculptural imagery constitutes a distinctive body of sources for the arts in Australia generally, although their role thus far might more aptly be likened to that of African and Oceanic works in the rise of twentieth century primitivism in western European art, than to that of the manuscripts of Constantinople circa 1453. The Renaissance was, among other things, a scholarly revolution. By contrast, Picasso was able to remark, in effect: 'Everything I need to know about Africa is in those objects' (Rubin 1984: 74).

However, Albert Namatjira, on the face of it, is a reverse case: an Aboriginal person who painted in the European-Australian watercolour landscape style. The handsome new book of around 30 colour plates and nearly 40 pages of text which is part of the subject of this article begins with a 'celebration' of the painter's life by Nadine Amadio. Here we are helpfully told of the important retrospective exhibition of Namatjira's work held at the Araluen Arts Centre in Alice Springs in 1984, and curated by Mona Byrnes. This signalled a revival of interest in a painter who had become an Australian household name by the 1950s but whose reputation had never been very secure among curators and scholars of art and whose reputation declined after his death in tragic circumstances in 1959.

Amadio's chapter carries the obligatory post-1960s enlightenment regarding the falsity of applying the ordinary sense of the term 'primitive' to Aboriginal art. While bending a knee briefly to Namatjira's belatedly recognised (and poorly documented) concern with *country* and sites of mythological significance, this chapter succeeds nevertheless in rescuing and promoting Namatjira as a naive artist (my term, not hers) in another sense: instead of High Chocolate Box we now have Grandma Moses.

Amadio is especially concerned to frame Namatjira's work within the traditional key symbols of western European art mythology. He was a 'true painter' (p. 5) with his 'own vision' (p. 6), who 'knew the joy of a full creative life. He must have possessed an extraordinary drive and passion' (p. 2). His 'drive' or 'creative drive' is referred to repeatedly. Strangely posed next to this supposed 'drive' is Namatjira as Nature's Gentleman, a man whose 'dignity' and 'natural dignity' (p. 10) are to be remarked upon, and whose pictures are noted for their pellucid, airy calm and balanced repose. They are also pictures of beautiful (and largely unpeopled) landscapes, excluding even a hint of the nasty side of life available in and around the Alice Springs of his time.

Jonah Jones' short piece on the 1984 exhibition, where a remarkable 56 Namatjiras were assembled, is of particular historical value, although one could have done without the mystification of the comparison with Piero della Francesca on page 18 ('It is all there! What is? And what is it?').

Daniel Thomas's chapter re-evaluates Namatjira's relationship to the art world. It is the best chapter by far and says some new and substantial things about Namatjira's work. He points out some major reasons why Namatjira's work was only slowly recognised by art professionals; it came out of the tourist industry; it was exhibited in unprestigious locales for much of his life; vice-regal patronage made art scholars suspicious; watercolours were strongly associated (as they still are) with amateurism; and Namatjira painted in a style that was already considered conservative and hackneyed by 'professional, vocal, modernist' artists. Yet he painted with the best of those characteristically Aboriginal artistic qualities of 'extreme delicacy, refinement, and gentleness' (p. 26). Finally, Thomas makes the important observation that Namatjira's art, which was seen in his own time as 'European',

is now 're-Aboriginalised' because of three main factors: its reference to significant country; its symbolic repetitiveness; and its fineness of touch. Our altered understanding permits us now to admire it more fully, and to be moved by it' (p. 26).

The other excellent chapter in the book is that by Anne Blackwell, a young archaeologist and historian who sadly was killed in a car accident in Central Australia in 1986. While Thomas' chapter excels in ideas, Blackwell's excels in historical fact. The history of Hermannsburg, the roles of Carl Strehlow and E. W. Albrecht there, the creation of the Aboriginal craft industry, the biography of Namatjira, and the emergence of a Hermannsburg watercolourist 'school', are presented with scholarly attention to detail and handsomely illustrated. It is here that we find, amazingly, the only remark on Namatjira's work by an Aboriginal person: 'That old man — he painted'. This is reminiscent of Amadio's comment about the Papunya acrylics painters on p. 13: 'Every painting they point to, they say simply, "this is my country" . . .'. Typically, a lengthy explanatory discourse or even a brief gushing eulogy or critical sideswipe is an unlikely Central Australian Aboriginal response to a question about a painting. This does not mean that extensive records cannot be made of what people know, think and feel about a picture. It does mean that much patient and laborious investigation has to be invested in the process by the outside enquirer.

Forming the last section of the book, the colour plates are perhaps the best guide to the aesthetic apparatus of lovers of Namatjira's work, because they are accompanied by captions which use phrases such as: 'richly-toned . . . warmth and sensuality . . . simple beauty of form . . . an earthy power' (p. 46); 'delicacy and economy' (p. 48); 'a gentle and lyrical painting, restrained in colour' (p. 89). Throughout evaluations like these both here and earlier in the book the recurring themes are:

1. Innocence, naïveté, gentleness, restraint
2. Fineness, delicacy, tonal subtlety, economy, accuracy
3. Lightness, energy, vitality, drama, vibrancy, urgency
4. Optimism, celebration, fancifulness, warmth, sensual response.
5. Vastness, distance, openness of space
6. Repetition.

I think this lends some weight to my suggestion that Namatjira has emerged as a naïve but technically proficient and respectable painter, in the assessment of many of his admirers. In the past, it was his falsely supposed lack of sophistication which played such a commanding role in his lionisation and demotic fame among suburban Australians. His intellectual sophistication is now seen to lie in the relationship between his pictures and

the geographical sites and geographical religion they represent, rather than in some happy fusion of his High Culture with his manner of representation. Had he done the same works in the 1980s, though, this may not have been the case at all.

Namatjira's is the gentle innocence and 'natural dignity' of someone 'close to the earth' and unpolluted (or just about to be polluted) by the industrial civic culture. This is not the gentleness (gentility, genteelness, gentrification, gentlemanliness) of restrained passion so characteristic of 'civilisation', where some sign of the wildness that has been domesticated must remain if art is to avoid being too wishy-washy. This is the clarity of Eden.

And I suggest, also, that this analysis might to a lesser degree apply to the generally positive response by art lovers to the Aboriginal acrylics which have so rapidly displaced Hermannsburg watercolourism from centre stage in the Centre. Technically variable but usually far from technically incompetent, the acrylics are — especially when documented — genuinely appealing depictions of the concerns of a tradition which seems free of the tired baggage of self-comment.

While Albert Namatjira painted (for sale, at least) the typically horizontal view of landscape of the European art tradition, the acrylics painters present us with images of place viewed from a perpendicular, aerial photographer's perspective.

Papunya paintings, Papunya Tula Art, Pintupi paintings, Western Desert paintings, Aboriginal acrylics, the dot paintings — the term has yet to settle down, perhaps reflecting two persistent uncertainties. One of these uncertainties rests on the fact that most of us who talk about the works have at best a partial grasp of their social and cultural location, or indeed that of any art or artefactual style in Aboriginal Australia. Another uncertainty arises from the fact that, fifteen years after the birth of the Aboriginal acrylics 'movement', it is still mainly known through exhibition ephemera, TV programmes, brief magazine articles, and small sections of survey works such as the excellent introductions to Aboriginal art by Berndt, Berndt & Stanton (1982) and Isaacs (1984).

In other words, there is no major, sustained, scholarly study of these paintings available, and which is on a scale comparable to Nancy Munn's *Walbiri Iconography* (1973) or Howard Morphy's unpublished thesis on north-east Arnhem Land bark paintings (1977). Such a study would form an authoritative basis for characterising the works. An historically oriented study of this kind is now urgently needed, for the acrylics are not only a 'style', a 'genre', a 'movement' (spreading phenomenon, at least) and an 'industry', but also a rapidly developing 'phase' in a very old graphic tradition

— in fact, the very one Munn was writing about twenty years ago.

The catalogue or book *Dot and Circle*, edited by Janet Maughan & Jenny Zimmer, lies somewhere between the handy but lightweight ephemera, which usually throws up unintegrated fragments of fact (and fiction), and the full-scale scholarly study which turns an array of facts into a body of knowledge and interpretation.

In one of its facets, *Dot and Circle* is a listing and reproduction of the 102 pictures shown in the exhibition of the same name lent by the Flinders University Art Museum to the Royal Melbourne Institute of Technology Gallery in April-May 1985. They later returned to be shown at Flinders University in Adelaide. The catalogue is valuable not only because it lists the works and their often considerable documentation, but also because it reports the exhibition itself in the form of photographs of the installation and its opening, lists of case exhibits and exhibition photographs, and a reproduction of the exhibition text labels. Inventories of the first year's consignments of acrylics from Papunya to the Stuart Art Centre 1971-2, provided here by Pat Hogan, and the appendices detailing works painted by David Corby Tjapaltjarri and Turkey Tolsen Tjupurrula while Aboriginal Artists in Residence at Flinders in 1979, may also be mere lists but they will be of much greater historical interest as time goes by.

In its other, more discursive role the book does provide a collection of brief essays on the origins and significance of the acrylics movement by a variety of authors. There is little intellectual coherence between the essayists here, however. Geoff Bardon's account of the sudden adoption of acrylic painting at Papunya during his time there in 1971, here reprinted from his 1979 work (Bardon 1979), is a reminiscence of importance to Australian art history and also a work of great honesty, even if at times it shows an unnervingly slight grasp of the culture of Aboriginal people. Dick Kimber's much more savvy recollections of the same period follow those of Bardon and very usefully cite the names of the key European supporters of the 'movement' (As Kimber says, rather paradoxically, it is 'only a movement in European eyes accustomed to crowds rather than individuals' (p. 19).) It is clear that the acrylics are, and always have been, very much a direct product of particular Aboriginal-European interactions, not simply 'Aboriginal products' sought and bought by Europeans.

Another reminiscence in this collection, Rodney Morice's 'The Kungkayunti experience', is the exceptional essay in the literary sense — it is beautifully written, it is alive and conveys the quality of daily experience in a remote Aboriginal camp, and it rings true, as the work of someone who was

there long enough and had sufficient sensibility to get it right. As a means of orienting the reader to an unfamiliar world it is excellent, even though its relation to the business at hand is rather general (and like the Bardon piece it is a reprint (in this case, from *Overland* 1978)). The heavy dominance of the overview in the presentation of the Aboriginal arts is, I hope, soon coming to an end.

Andrew Crocker's essay, 'Potential and pitfalls', promotes the view that Aboriginal works should be allowed to take 'their place in the contemporary artistic forum', and supports the view that the evolution of Aboriginal art 'enables those Aboriginal artists with an exceptional artistic flair to flourish' (p. 47), opposing the restrictive attitude of 'traditional is better'. The possibility that the Papunya paintings emerged from an assertion of traditionalism by older men sits uneasily here — it does not invalidate Crocker's view, but it does cry out for consideration.

The sections of the book which will perhaps be of greatest interest to scholars of art history and material culture are those by Janet Maughan and Vincent Megaw. (By 'material culture' here I mean to include aesthetic anthropology, as well as the less theoretically-oriented branches of that field.)

Megaw, an archaeologist by training, has published a number of papers on the Aboriginal acrylics phenomenon. This one, 'Dreamtime discipline or alien adulteration?', stresses a theme similar to that of Crocker's piece which precedes it: that the 'fine art' status achieved by Aboriginal works is legitimate, and that commercial and institutional recognition (or should it be 'constitution?') of that fact is inevitable. People who complain of capitalist penetration of Aboriginal society via art are idealising, romanticising and attempting to fossilise its culture, Megaw suggests that change in Aboriginal art is not adulteration of a pristine, noble culture by a greedy, foreign one but a sign of Aboriginal cultural vitality in the modern world.

Like his other papers on similar themes, Megaw's essay in this case questions the rationality and the morality of distinctions such as fine art/tourist art, art/artefact, art/craft and so on, meanwhile raising the problem of applying aesthetic judgements across cultures. Several positions on these subjects are adumbrated, none of them is particularly rigorously pursued, and few of them are plumped for other than gingerly. The profession of archaeology is mentioned in an act of dissociation of the author from the philosophy of art or art criticism.

Jenny Zimmer's preface (oddly, one of two, the other being by Maughan & Megaw) provides much useful information on the creation of the exhibition itself. As a performance it must go down as one of the most orchestrally complex in Aboriginal art history. She also offers some revealing thoughts on

why such an exhibition was considered useful as part of the education of some Melbourne art students. There is not room here to argue all the points she raises, although most of them are arguable.

Her most interesting point is summarised in her last paragraph: '**Cultural Convergence** can only serve to make our culture richer and more authentic. This exhibition and booklet are dedicated to the concept of **Cultural Convergence**' (p. 13, bold print original).

Perhaps this is an implicit stand against the recent avalanche of Left criticism in this field, which resounds with phrases like 'cultural genocide', 'aestheticisation' and 'neo-colonialist encapsulation'. It may also be a recognition of the fact that a new Australian sub-culture has been emerging for fifteen years or so among people of no Aboriginal ancestry, many of them resident in Central Australia. They are creating a partly new way of life, one affected by a perception of Aboriginal culture and by interaction with Aboriginal people, yet distinct. This theme is reflected in the final section of the exhibition and catalogue, which is called variously 'White artists using Aboriginal designs' (p. 18), 'The Western Desert image and the European art context' (p. 25), 'Across the cultural divide' (p. 191) and 'Across the cross-cultural divide' (p. 205).

Tim Johnson is a non-Aboriginal artist who has used graphic devices drawn from the Aboriginal acrylics and who has painted jointly with an Aboriginal artist (see cat. nos. 97, 98). Whether this is best described as 'convergence' or 'incorporation' (etc.) has been a matter of debate. Whether it has yet resulted in 'good works of fine art' has also been a matter of debate. The latest wave of European artists influenced by Aboriginal graphs can probably claim a moral, if not an aesthetic, advance over predecessors like Preston, whose contact with Aboriginal people was generally much more marginal and whose borrowing was done from photographs and museum collections rather than 'with the people'.

Not only artists but collectors and curators interested in the Aboriginal acrylics are beginning to talk of them as the first truly Australian art, *and* as a case of cultural convergence between Aborigines and European Australians. This perception, problematic as it may be, is gathering force.

I have left Janet Maughan's contribution to the end, both because it is the longest and because it is comparatively rich. She outlines the history of the genre and the referential meaning system of its images, and attempts a style analysis which, as she herself points out, fails to get off the ground (p. 17). I do not agree that such an analysis is not possible, however. The effect of variety perceivable among the pictures is great, certainly, but it is one which

rests on the recombination of a limited set of motifs and of ways of placing them in a symmetrical field. The list of motifs or recurrent symbols in Figure 2 (p. 16) seems to me seriously incomplete, and also conflates sets of symbols which ought to be kept distinct. No structural typology of the images is offered, although the works are eminently suitable for this kind of first-sort. It is difficult to see how a style analysis could proceed without some kind of sorting into the various kinds of axial symmetry, for example.

Maughan then goes on to discuss the major subgroups of works in the exhibition and the rationale for their subgrouping, beginning at the beginning (the early paintings), and moving on to look at two artists specially represented in the exhibition, Tim Leura Tjapaltjarri and Toby Brown Tjampitjinpa. This concentration on two individuals was important to establishing an idea of the style and output of particular artists over time.

Institutional roles in the acceptance and promotion of Aboriginal acrylics are highlighted here. The particular efforts of Visual Arts staff and students at Flinders University are given their due, though for better balance there could have been more emphasis, for example, on the historic role of Robert Edwards and the Aboriginal Arts Board in promoting both the production and the sale or public collecting of these works in the 1970s and 1980s.

'Children's paintings' (for, not by) come next, followed by 'Women's paintings' (by, not for), where it is made clear that women are under-recognised as painters in the genre and tend to produce for the 'craft' market. The question of how much this may be a reflection of gender roles in matters of religious authority is not opened up.

Maughan ends by relating Papunya paintings to conceptual art, but, in the absence of a discussion of what that is, many readers may find the connection obscure. It is a pity there was not room enough in her essay for a substantial discussion of the relation of the acrylic designs to those largely very similar ones of the same region which have been recorded since the earliest European times, but in other media: the rock intaglios, rock paintings, body decorations, shield designs, and the sand drawings of daily conversation and play.

Among Maughan's more interesting observations are the view that the complexity of figure-ground relations in the acrylics has increased over time, and her important statement that there is a gaping lack of published information on Aboriginal criteria for merit in paintings. Great credit is due also for her long and detailed work on the catalogue annotations.

The production quality of the book leaves much to be desired, but most of my reservations there

would have been pre-empted by more generous publication funding of typesetting and layout, printing and binding. The page size (A4) is unattractive; it needs to be more squat. The 13 colour plates are fine but the monochrome plates are rather muddy. In one case a signature has been chopped in half (p. 104) and in another the alignment marks have intruded (p. 111). Lines wobble.

Perhaps more serious are editorial lapses such as uncaptioned plates (pp. 1, 4, 8, 12, 41, 48, 93), typographic errors, and the entirely wrong information under the plate on p. 20 which says: 'Western Desert: Demonstration of circular designs which have in part replaced the more complex traditional ground paintings. Photo: Penny Tweedie.' This is actually a photograph by C.P.

Mountford taken at Haasts Bluff in 1942. This mistake is perhaps partly compensated for by the humour value of the caption to the upper photo on p. 46: 'Old Mick Tjakamarra with Daphne Williams recording the story of the painting, 1982. Photo: Vincent Megaw'. Ms Williams, apparently short of paper, is on close inspection writing down the details in her Bank of New South Wales cheque-book. . .

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